SEPTEMBER, 1948

TWO SHILLINGS

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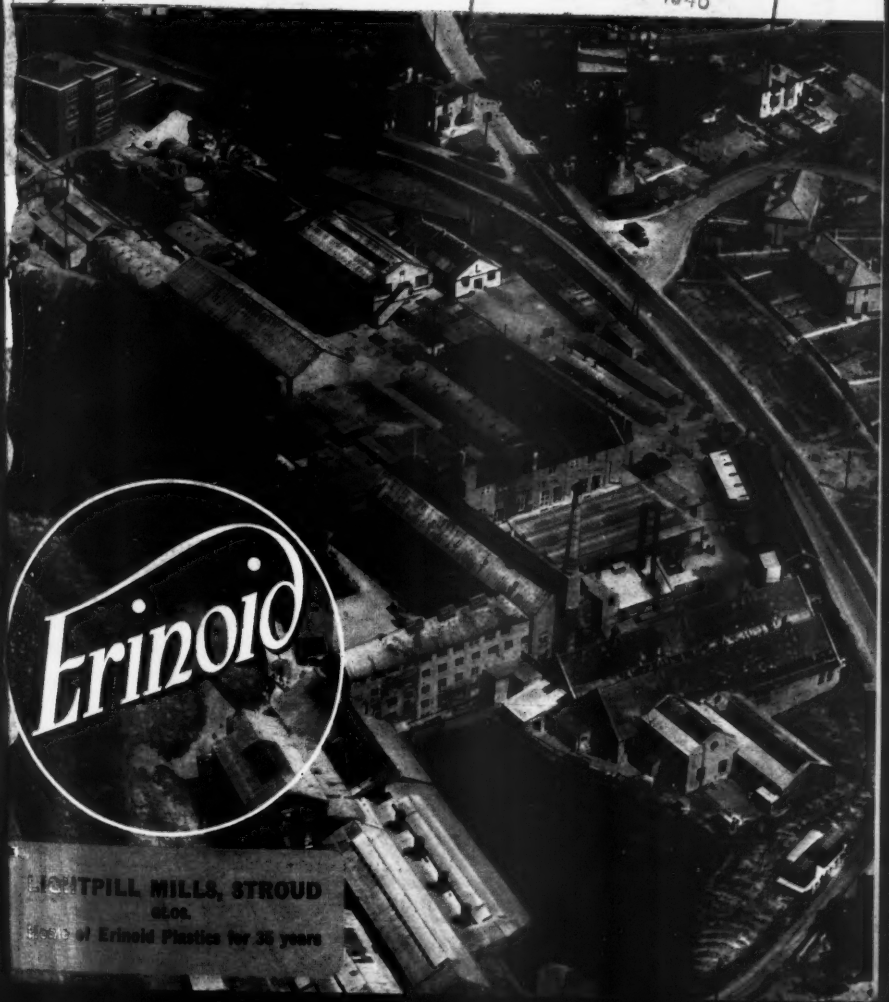

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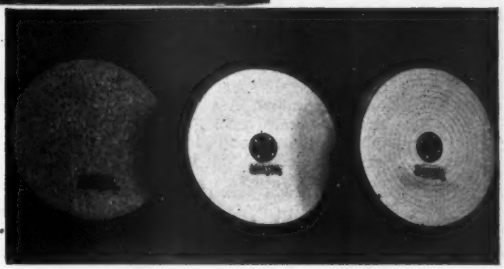

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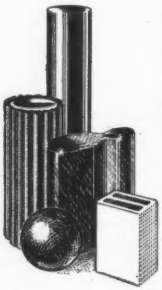

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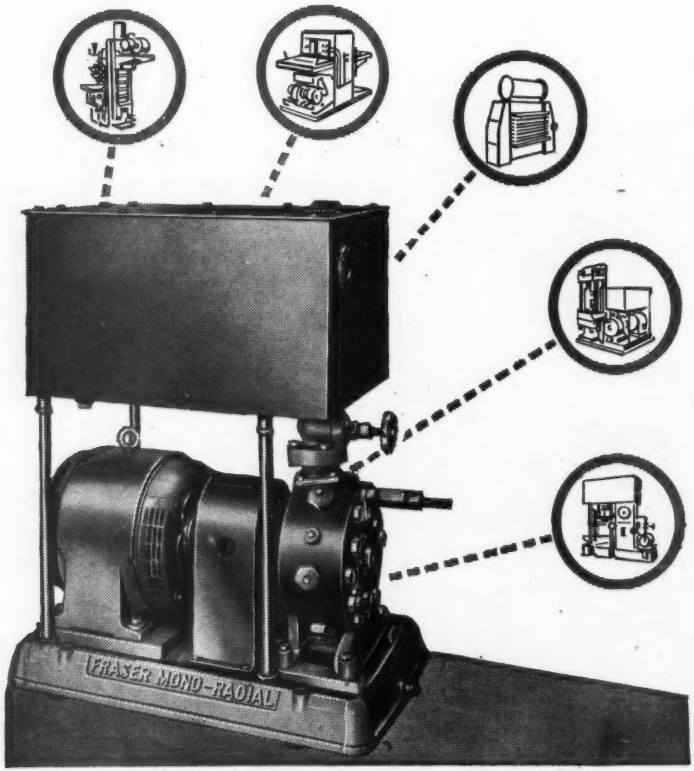

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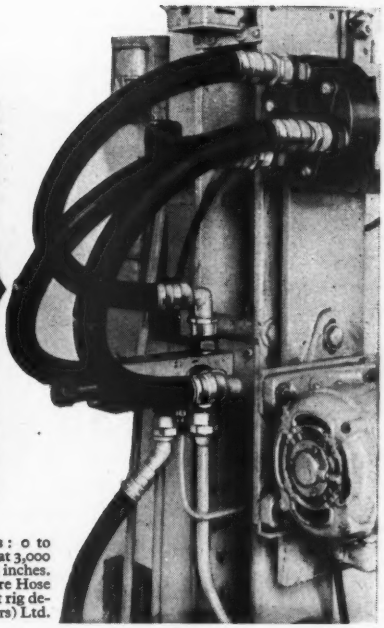
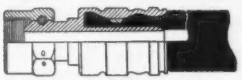
Hycar meets RAE Spec. AD 101



SECTION III G-4: 100 hour pressure impulse tests: 0 to 3,000 lbs. per sq. in. every five seconds while flexing at 3,000 cycles per minute at an amplitude of not less than 0.05 inches. Photograph shows Palmer "Silvoflex" High-Pressure Hose units fitted with Bowden Patent Couplings on the test rig designed and constructed by Messrs. Bowden (Engineers) Ltd.

RIGOROUS TESTS to AD 101 confirm the right choice of Hycar for the linings and covers of Palmer's high-pressure hose units for fuel and oil systems on aircraft. Hycar *combines* a high degree of resistance to oil and petrol with the low cold flow characteristics vital to the efficiency of the rubber-to-metal union in the couplings. Hycar is the essential material for all flexible parts which have to give long service with complete dependability although in constant contact with oil. For further information on the properties, processing and supply of Hycar OR synthetic rubber, please write to :—



Bowden Pats. 540489/90/91/92 etc.

In swaging Bowden Patent Hose Couplings to the hose, as shown in the above diagram, considerable pressure is employed. But due to the reluctance of Hycar to cold flow a perfect rubber-to-metal joint is achieved and maintained throughout strenuous test-bench and service conditions. *Photograph and diagram by courtesy of Messrs. Bowden (Engineers) Ltd., and The Palmer Tyre Ltd.*

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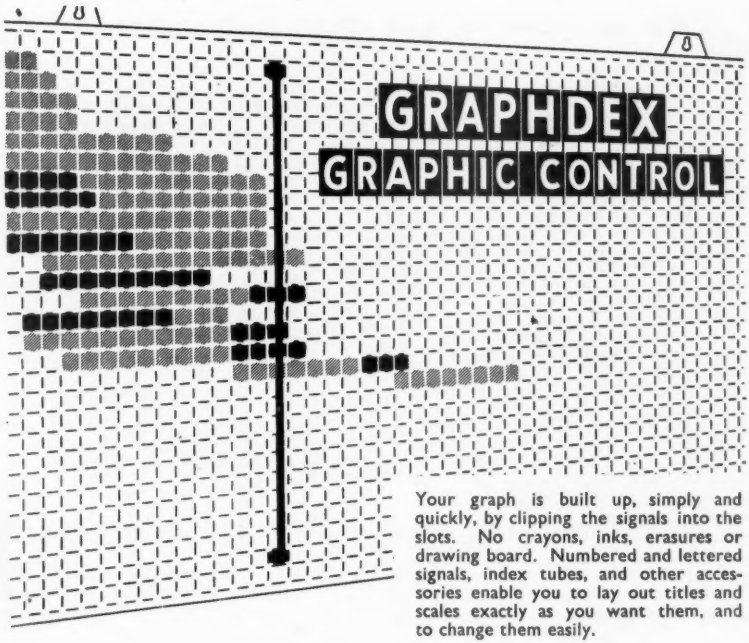

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This was a popular practice with the local housewives who were able to collect hot water by the bucket, but a rank bad one from the point of view of industrial economy. A pumping trap was recommended and, by this means, all condensate was returned for boiler feed, and down went the cost of the factory's steam.

Bad or out-of-date habits in factory practice are often allowed to linger on unsuspected. Even the best of us have mental blind spots—Jack Dempsey himself once forgot to duck! But there's one sure safeguard that management *can* take, and that is to ask the Ministry's Fuel Engineer along.

The very fact that he will be on fresh ground may enable him to spot some wasteful practice that has persisted since great-grandfather's day. Whether you follow his advice or not is entirely up to you, but you can be sure that any suggestions he makes will be sound and sensible.

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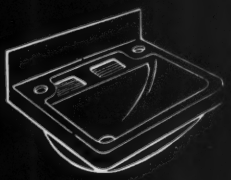

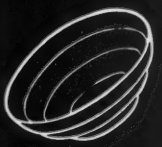

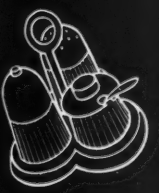

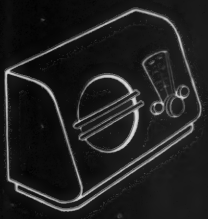

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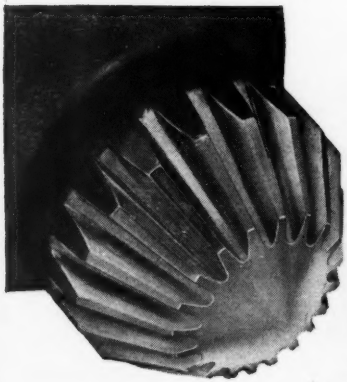

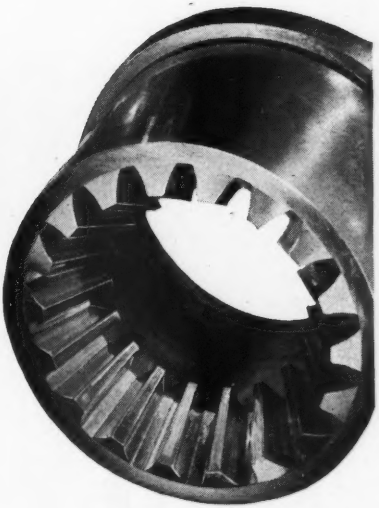

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P/487/P82

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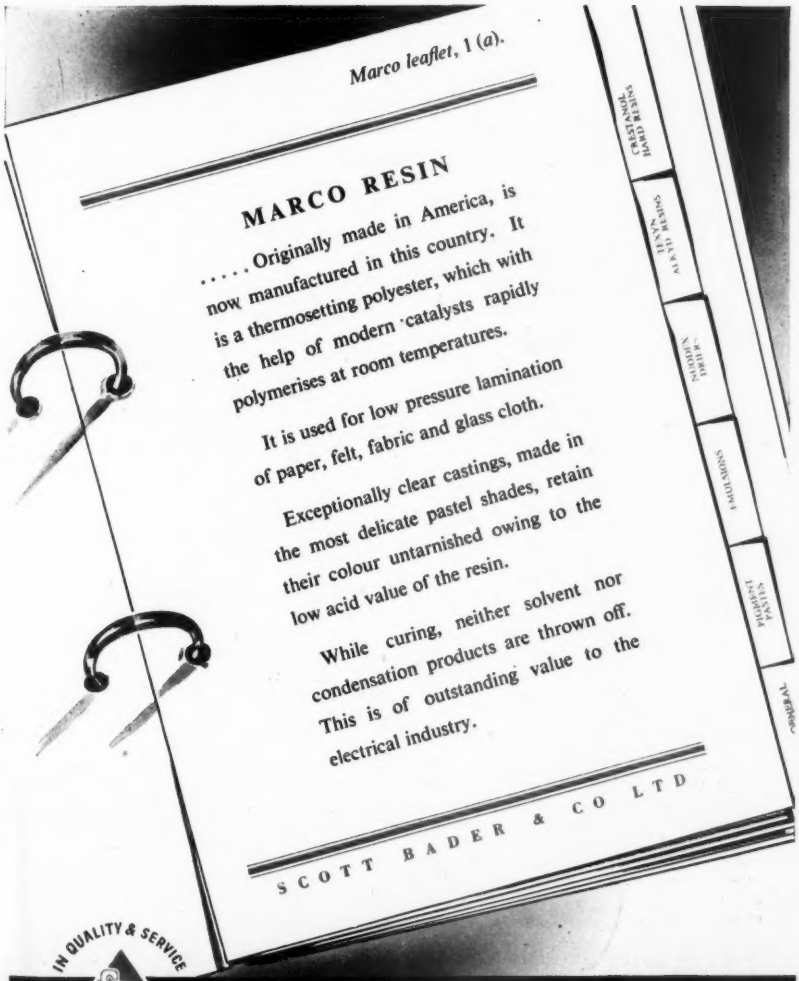
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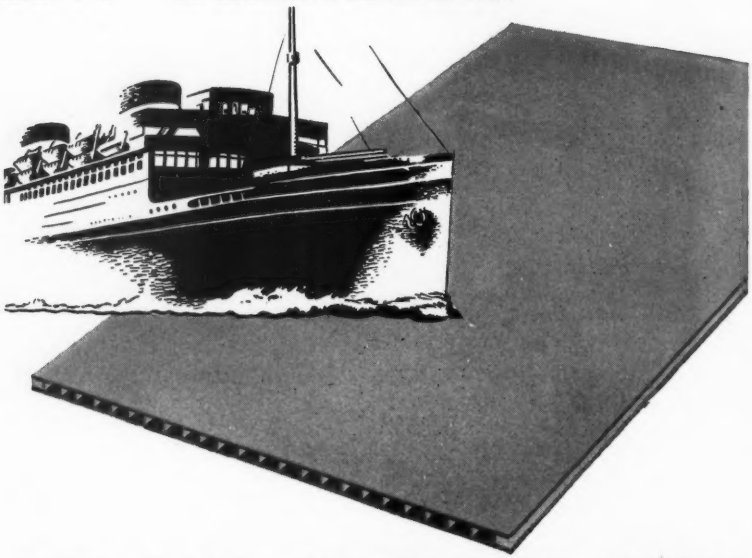

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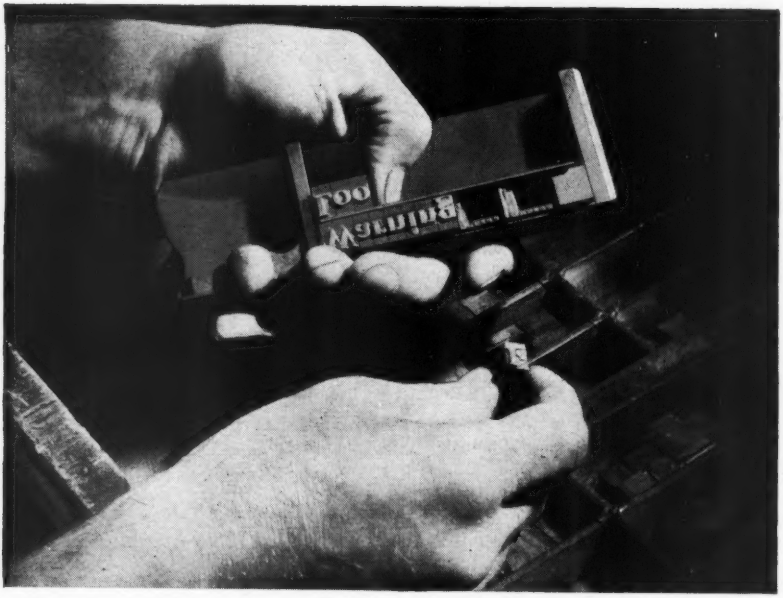

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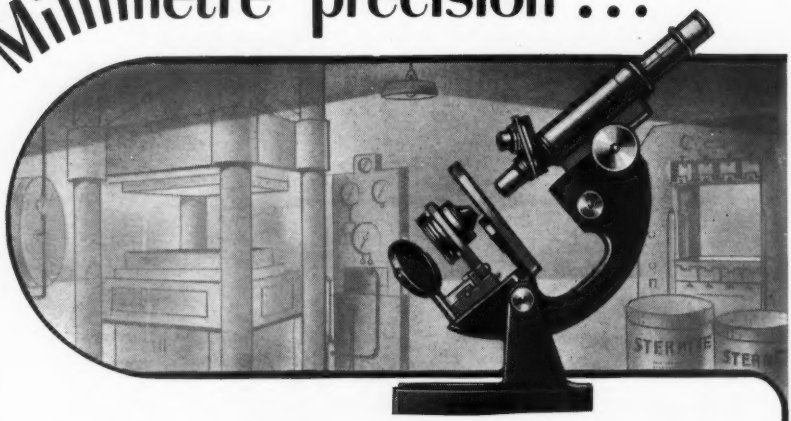

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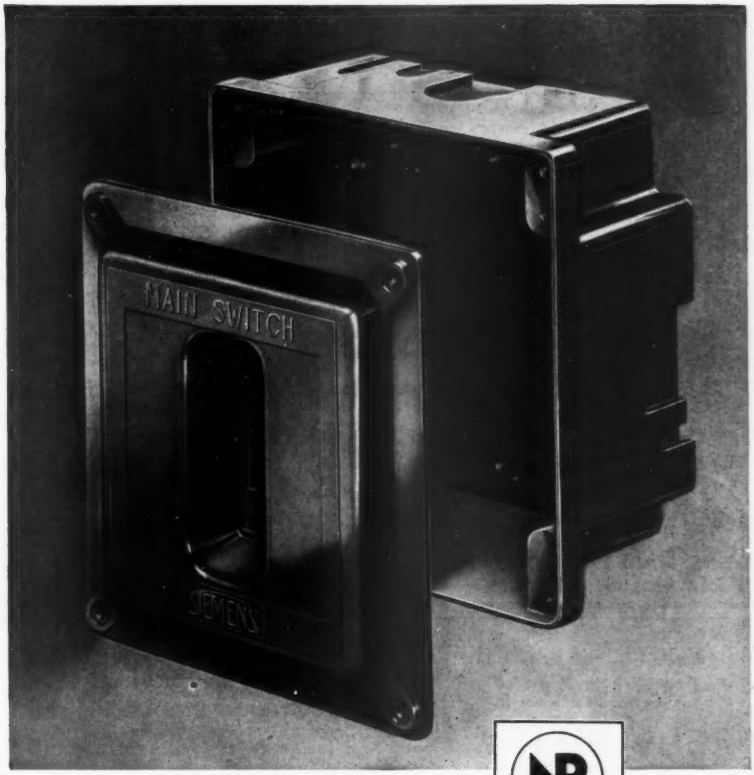

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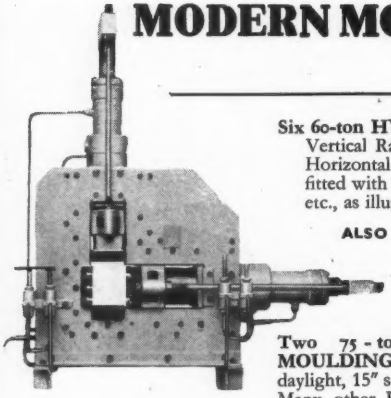

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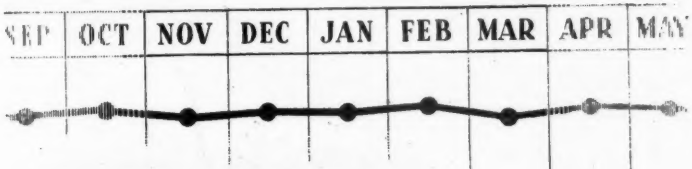

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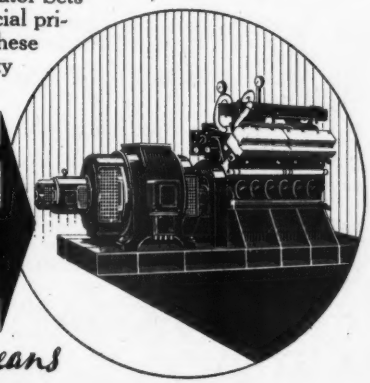

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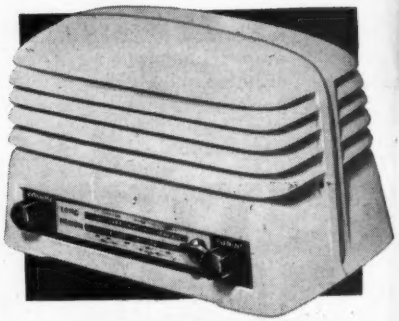

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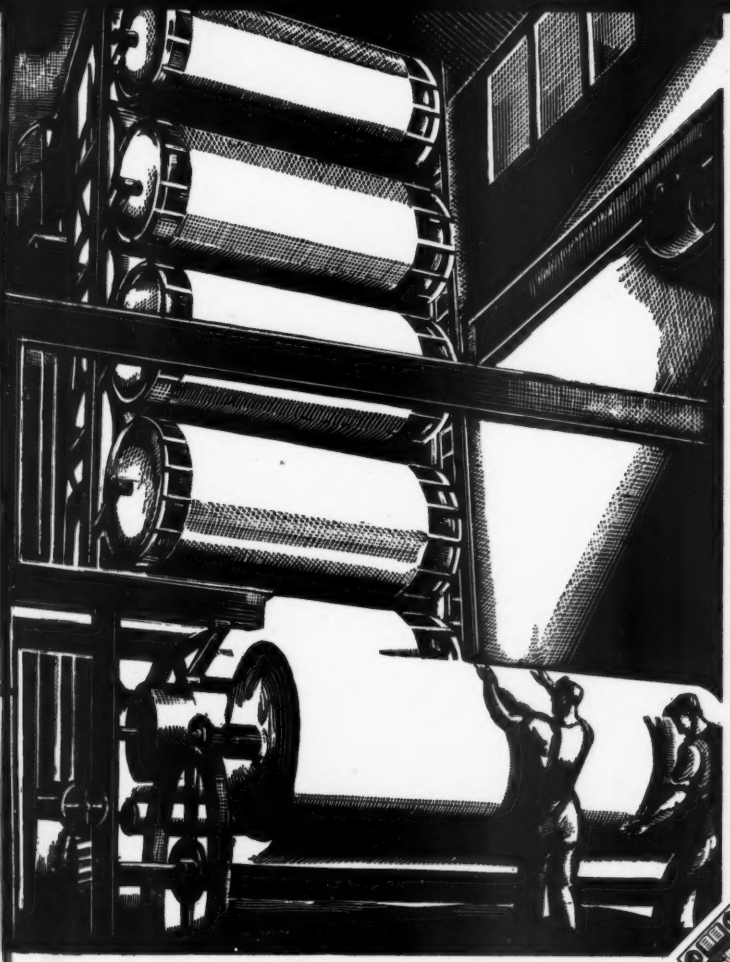

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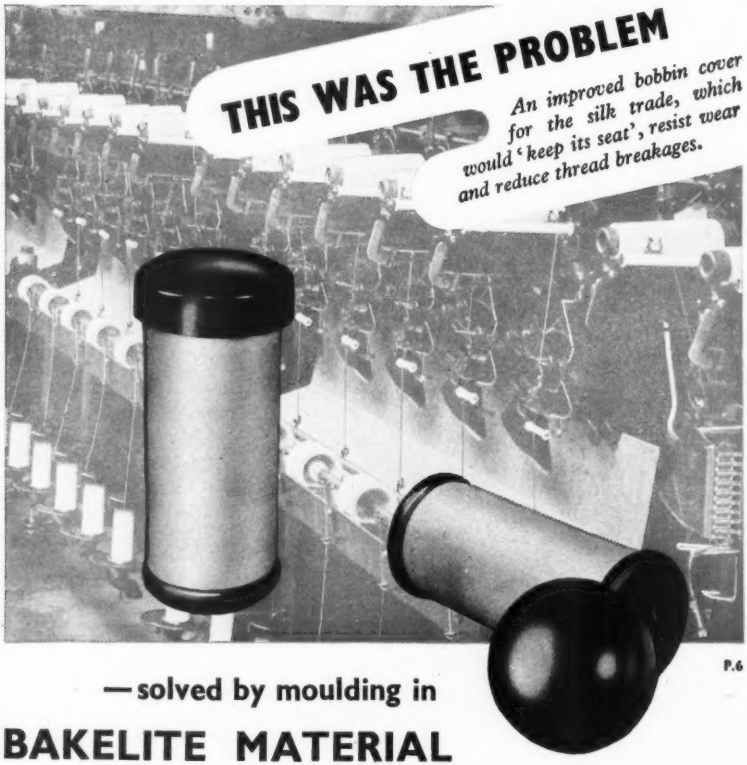
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P.6

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Vol. XII. No. 136 SEPTEMBER, 1948

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Chairman and Managing Director ROLAND E. DANGERFIELD

Editor - - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - - Bowling Green Lane, London, E.C.1

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NOTICES

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EDITORIALS

Plastics in Scotland

WHEN in May, 1946, we commented on the interim report by the Committee on Plastics of the Scottish Council on Industry, regarding the possibility of creating a self-contained plastic industry in Scotland, we felt sure that all south of the Border would cock a sympathetic ear.

We noted then that the number of moulders and fabricators was lamentably small (about 12), and that there existed no production of raw materials to feed a plastics industry. Furthermore, only one or two engineering concerns had undertaken mould making and this in an intermittent way.

With the general world acknowledgment before us that there are in Scotland academic and technical chemists, physicists and engineers, the equal of any others, all highly advanced technically, and, moreover, that the country has ample coal, a well-organized coal distillation plant, and existing petroleum and shale oil refineries, and finally a growing hydroelectric system, the absence of even a small complete plastic industry speaks of surprising and shocking neglect.

The Committee, since 1946, has examined the problems in great detail and has now published its final report which we may sum up as follows:—

There has been a welcome increase in the number of firms manufacturing finished goods from moulding powders obtained elsewhere. The number of concerns is now 23. On the other hand, manufacture of the ingredients to make moulding powders is quite static; no developments have been reported. Further examination of the engineering side of the problem indicates that while production of moulding plant is small, the engineering industry is in a position to tackle this highly specialized technique without difficulty.

Obviously no firmly established plastics industry can be envisaged until imports of raw materials are replaced by home-made chemicals, but it is also clear that, for example, coal tar phenol is insufficient and will not solve the phenolic resin problem. The production of synthetic phenol and cresol from benzene and cresol is a paramount necessity, and this can be brought to fruition by the existing adequate supplies of benzene and cresol and by the large potential for sulphuric acid manufacture in Government explosives factories. The manufacture of these basic compounds could be carried out in existing ordnance factories in the West of Scotland.

Maximum benzene output from coal tar is required and in addition phthalic anhydride for producing glyptal resins could be manufactured from naphthalene. One plant at present engaged in synthetic ammonia is easily capable of conversion for making methanol and the other important ingredient for resin production, namely formaldehyde.

Five per cent. of the estimated power of the hydro electric schemes set apart for carbide manufacture would make a substantial contribution to the needs of the plastics industry by using acetylene for the production of polyvinyl plastics and others, while ethylene and propylene can be produced from coke-oven gases or petroleum gas-cracking.

All such gases and liquids would, furthermore, form the raw materials for many plasticizers and solvents.

The Committee recommends that the engineering industry be approached to realize the need of dies and moulds, that the Ministry of Supply and the Director of Ordnance Factories be informed of the need for synthetic phenol manufacture in Scotland; that the former be also informed of the need for methanol; and, furthermore, that the Secretary of State be informed of the urgent need of an established carbide factory for

chemical as well as engineering purposes.

Finally, the Committee recommends that the Tar Research Association be invited to explore methods for the production of ortho-xylene and phthalic anhydride, the coke manufacturers be encouraged to produce ethylene, and the plastics and chemical industries informed that unsaturated gases could be made available from petroleum and shale refining.

The Wind Biteth Shrewdly

THROUGHOUT the ages the stage has had its troubles with the elements and Nature generally, and we do not mean the leaking of the roof nor the gales that blow under the green-room door. Compared with our modern efforts at the Albert Hall and His Majesty's Theatre, Shakespeare must have made a very poor show at shifting Birnam Wood to Dunsinane. As for the storm scene in "King Lear," a mere teacup—an odd drum or two, with a little roaring on the part of Bottom on off-duty nights. And how carefully he avoided snow scenes!

Our experience goes back no farther than nights at the old Lyceum, when the heroine, at the end of Act 1, was always thrown out of house and home in midwinter and snow falling fast, with a "cheeild" in her arms. Fathers were hard-hearted in those days.

Snow was curious stuff. There was, it is true, plenty of it, for was not Great Britain, with its highly literate populace, amply supplied with lashings of newspapers? But the newspaper chopping-machines employed, while intricate and ingenious in design, were somewhat erratic in action, often producing flakes the size of handkerchiefs or in long thin slivers that gave an air of "Fun on Wall Street, N.Y." after election results. Furthermore, much depended on the origin of the paper. If it had passed through a previous and temporary existence as a wrapper in a fish-shop, there was a tendency for surface adhesion and lumpy formation, with the result that the storm resembled more a free snowball fight among the gods than the silent fall and drift of feathery flakes.

Again, depending upon the temper, salary and fatigue of the boy in the flies, dispersion was rarely perfect. Indeed, story has it that during one particularly agonizing scene, where the old man was being chased in his drosky (or troika) over the steppes with wolves biting at his horses' hooves, the whole contents of a hundredweight sack was emptied neatly into the dickey of the said drosky (or troika). This was followed by the sack and the snow distributor himself, who had gallantly decided to offer himself up as a sacrifice to the hungry wolves.

Little wonder we no longer have such exciting scenes on the stage.

With the birth of films and of Hollywood, and the backing of illimitable finance, came the next great advance—the use of the highest-quality paper and the introduction of great aircraft engines and propellers to blow the paper and thus create bigger and better snowstorms. Who will ever forget the scene in which the well-beloved W. C. Fields, of the bulbous nose, was blown through the door of the snowbound shack in Alaska? The very elements seemed to condense the alcoholic content of his breath.

In this momentous struggle towards perfection Hollywood on occasion would trek towards the local Rockies to take shots in real snow, but our heroes and our heroines complained so much of cold feet and rheumatic twinges that it was never a real success. Besides, blue noses consorted ill with gorgeous Technicolor.

Considerable use was made of plaster-of-paris and of salt, but only ground effects were successful. Even so, the mysterious footprints were not reproduced too well and seemed to go nowhere in particular. On occasion, too, errors were made, and one wounded hero of the Canadian Mounties, after dragging his weary and shattered bones 50 miles to the nearest Indian settlement, was heard to complain that the snow

tasted bitter rather than salty. Unfortunately, a few tons of crushed Epsom salts had been delivered inadvertently with the main consignment.

So we come now to the plastics era and the birth of a British invention which will widen enormously the scope of British stories. (You will have noted that producers here avoid snow scenes like the plague, mainly because all the plaster-of-paris is collared by the building industry, and because we have only enough salt for our monthly egg.)

Plastics come to the rescue through the research of Expanded Rubber Co., of Croydon, which has been producing ultra-light insulating material for many years, has now succeeded in manufacturing what must be the ideal snow from expanded urea-formaldehyde resins.

If you wish to learn more about this discovery, turn to page 459, where the secrets of the Rank Organisation at Ealing Studios are laid bare.

Plastics for Telecommunications

THE Telecommunications Research Committee, constituted in March, 1946, under the D.I.S.R., has now published the reports of its working parties which were appointed to survey existing knowledge in their various fields with the object of determining what gaps and deficiencies in that knowledge required attention. In this publication, to which we make further reference on page 464 of this issue, the importance of the dielectric properties of materials is particularly stressed. Dielectrics may be ceramic, polymeric (which apart from plastics and elastomers, according to the present report, also includes certain waxes and bitumens), or vitreous (glass and micas). Consideration of the available data for all these materials indicates that further work must be done on the dielectric theory, and also that there is need of better knowledge of the factors which govern the deterioration and also service limitations of such materials.

With polymeric materials, which cover a very wide field, and include those used in bulk form and as coatings and impregnants, the present report states that particular attention should be given to intrinsic electric strength and the effect of discharges. Permittivity, dielectric loss and absorption, and mechanical properties, especially thermal stability and impact breakage of plastics, are also of great importance.

A tabular summary of specific requirements for materials research refers to the polymeric materials under six headings. The development and use of "expanded" plastic materials, for example, indicates the need for an extension of known "expansion" techniques applied to suitable plastics, especially with a view to their application as low permittivity and low loss insulants for cables. Secondly, it is suggested that the development of plastics-bonded metal sheet calls for more knowledge on metal-plastic combinations having good prospects of mutual adhesion; the results of such work would provide applications as light-weight screening material for telecommunication sets to be operated under extreme climatic conditions. Thirdly, there is need for materials which can claim to be distortion-free over the temperature range −60 to +120 degrees C. under both moist and dry conditions, in order to fill applications in apparatus for use in extreme climatic conditions.

Under a fourth heading comes the investigation of ceramic-loaded plastics, with experiments directed to the reduction of losses in mixed dielectrics, and leading to applications as high permittivity materials; fifthly, the manufacture of thin films of materials with high softening points, with application in capacitors for use at high temperatures.

Lastly, an investigation of plasticizer migration, and the development of new materials to meet high temperature requirements, would find use in connection with jacketing materials in radio frequency cables.

Resin-bonded Diamond Wheels

By P. Grodzinski, A.M.I.Mech.E.

THE bonding of abrasives by plastic materials has been practised for a very considerable time. Probably the first use of such wheels was by the Tamils, inhabiting Southern India and Ceylon. Their wheels consisted of lac-resin or shellac (one-third by volume) and powdered corundum (two-thirds by weight). A detailed description of the process employed is given by C. Holtzapffel ("Turning and Mechanical Manipulation," 1864/3/1,049):—

"The corundum powder is put into an earthen vessel and heated over a clear fire; and when of a sufficient heat (which is ascertained by a small piece of the resin readily fusing), the resin is added in portions, carefully stirring at the time, to form an intimate mixture. When made into a mass, it is put upon a smooth slab of stone and kneaded by beating it with a pestle; it is then rolled upon a stick, reheated several times, continually kneading it until the mixture is perfectly uniform. It is afterwards separated from the stick, laid again up a stone table which has been previously covered with very fine corundum powder, and flattened into the form of a wheel by an iron rolling-pin. The wheel is then polished by a plate of iron and corundum powder; and finally, a hole is made through the middle of it by a heated rod of copper or iron. These wheels are made with a grain more or less fine, as the coarser perform the first rough work and the finer cut the stones. They are mounted on a horizontal axis, and the workman, sitting on the ground, makes them revolve with a spring-bow, which he moves with his right hand, at the same time holding the stone with his left against the wheel, the latter being, from time to time, carefully moistened and sprinkled with corundum powder. The polish is given by wheels of lead and very fine corundum powder."

The first suggestion to produce a resin-bonded diamond-grinding wheel probably came from the inventor of the phenol-formaldehyde resin, which was hardened under heat and pressure, for it was Dr. L. H. Baekeland who obtained U.S. Patent 942,808 in 1907 for incorporating silicon carbide (carborundum), corundum, emery, or softer granular abrasives or polishing materials in a phenolic body and formaldehyde, subsequently making an insoluble condensation product by application of heat and pressure. Diamond, however is not mentioned in this specification; the earliest patents for methods incorporating diamond abrasive in plastics became known about 1932.

Leaving the matter of patents for a moment, it may be stated that phenolic resin-bonded phenol diamond wheels are still produced in large quantities, in spite of the fact that serious competitors became known in metal-bonded and vitrified diamond wheels. This shows that the original idea of using a thermo-setting resin still produced a diamond-grinding wheel, which is extremely useful for a large number of purposes, particularly for the hand-grinding of sharp edges on hard materials where the resiliency of the bond is of particular advantage. Tests have even been carried out to show that resin-bonded diamond wheels are capable of giving an extreme cutting performance, which is seldom achieved even with harder bonds.

A thorough compilation of patents referring to diamond abrasive wheels in general has just been published.* The subject matter is grouped according to the types of bond used—synthetic resin, rubber, vitrified, metal and miscellaneous

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materials, including shellac. Regarding the synthetic-resin and rubber-bonded groups, the number of patent specifications listed is set out below:—

Synthetic Resin :
(a) Thermosetting. Phenolic (40); amino (21); alkyd (4); silicone (1).
(b) Thermoplastic. Vinyl (12); acrylic (15); styrene (1); cellulose (5).
Rubber : (a) Natural (17); Synthetic (18).

Whereas the writer is aware that only thermosetting resins have been used in practice, the present survey shows that a large number of thermoplastic resins have been recommended for this purpose, although, obviously, such products are not commercially made at present.

In spite of the fact that a sharp dividing line is drawn between thermosetting and thermoplastic resins, the patent specifications consulted do not readily lend themselves to any such rigid grouping. According to the present state of development, there are some resins which cannot be so strictly classified; for instance, some acrylic resins (co-polymerized methyl methacrylate and glycol dimethacrylate) are more thermosetting than thermoplastic, yet for convenience all acrylic bonds have been grouped under the same heading. Further, it has to be considered that several types of bonds may be applicable and a patent may actually belong to more than one group. Still further, in this compilation a number of patents had to be cited although referring but generally to the application of an abrasive which was not further specified, in spite of the knowledge that the applicants or assignees use such specifications for covering their diamond-wheel products.

The introduction to this summary of patents on diamond abrasive wheels gives a fair cross-sectional view of the very wide field of application which is covered, as also some particulars on the trend of development.

Mixtures of phenolic resins with fibrous material, e.g., U.S. Pat. 2,051,558 (1933) and Swiss Pat. 170,525 (1932), and with metal powders, e.g., Brit. Pat. 548,536 (1941), have been proposed. Another thermosetting resin, the alkyd or glyptal type, was suggested as an alternative to the phenol-formaldehyde type in U.S. Pat. 2,065,041 (1936). Following the introduction of other resins, we find many of them are proposed as bonding agents, although some of the newer thermoplastic materials are less heat-resistant, or have lower softening temperatures, than some of the phenolic thermosetting materials. For example, the use of polyvinyl compounds was suggested in Ger. Pat. 734,828 (1938). One of the more heat-resistant of the acrylic resins, viz., co-polymerized methyl methacrylate and glycol dimethacrylate, was proposed in U.S. Pat. 2,189,733/4 (1938). On the other hand, the use of the less heat-resistant copolymer of methyl methacrylate and methacrylic acid is described in U.S. Pat. 2,256,618 (1937).

The thermosetting aniline-formaldehyde resins are proposed as bonding agents in Brit. Pat. 561,902 (1941), and many variations were subsequently described on most of the foregoing types of resin. In U.S. Pat. 2,319,791 (1942) a method is described in which the aniline-formaldehyde bond is cured by cold pressing in presence of a wettant-plasticizer, i.e., a chloracetate. The newer silicon ester resins, which possess very good heat-resistance, have been suggested for bonding abrasive grains in U.S. Pat. 2,389,491 (1945).

On the whole, these patent abstracts show a steady development to higher strength and higher heat resistance of the bond, together with greater control of distribution of the abrasive grain, the bond, and the pores between grain and bond. A number of patents, e.g., U.S. Pat. 2,272,873 (1939), discloses compositions, particularly for snagging wheels, which contain a high molecular-weight organic compound which splits off acid at high temperatures. It is stated that the acid causes the metal chips to be cleared more readily from the abrasive grains. In some cases, better heat conductivity is achieved by combining metal

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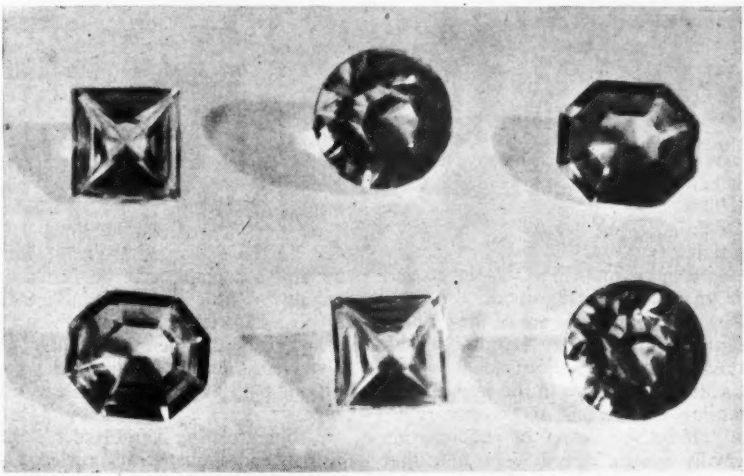
E'VER since history began, precious stones, the semi-precious opal, jade, tourmaline, garnet, onyx, malachite, and a hundred others, and the purely imitational made from glass, have always been in universal and undiminishing demand. Whatever the given reasons may be, intrinsic, rareness, love of colour, all stones rouse in their wearers emotions that seem allied also to the virtues, the evils, romanticism and even to that strangely wonderful physical property of transparent matter known as refractive index. It is indeed these very emotions that have created one of the greatest of small industries among human kind, in existence long before bejewelled King Solomon ascended his throne and fostered ever since by every female of the species throughout the globe.

So far as the plastics industry is concerned, and therefore considering only so-called imitation jewellery, and our hopes in it, one can be tolerably certain that every single one of the 15,000,000 women over the age of 16 or so in this country possesses at least one example for hat, dress, shoe or bag, quite apart from bangles and other adornments.

The decorations take on a thousand different forms, of ancient or entirely modern and novel design with every change of fashion, and the whim and inventive skill of the craftsman. Their infinite variety never stales and all add their quota to the pleasure and joy of millions.

The impact of plastics on this not-so-little industry began many years ago, certainly with the production of casein



Polystyrene artificial gemstones, showing facets, enlarged four times the size of the actual "stones." (Courtesy, Alfa Plastics, Ltd.)

plastics and probably before that, using nitrocellulose for imitation jade, onyx and the lovely green malachite with its jet-black veins.

A great step forward was taken with the making of transparent plastics, firstly by the Austrians and the French some 15 to 20 years ago, using thiourea resins which now seem to have disappeared from the world, and then, about 1934, with the introduction of the transparent colourful cast phenolics. It was certainly the introduction of "Catalin" into this country at the 1938 B.I.F. that startled the public here into a realization of the possibility of plastics as decorative jewellery.

At about the same time we first saw the work of Lady Margaret Crawford, who began carving and turning "Perspex" and producing veritable works of the jeweller's art by skilful cutting and taking advantage of the extra-ordinary optical properties of this plastic.

The production, however, of copies of precious stones, diamonds, rubies, sapphires and emeralds exact to colour, size and shape, with all their facets, by modern moulding methods, is a very new undertaking. Indeed, so important is the need for exact matching of colour and of complete understanding of the properties and vagaries of transparent plastics in the mould, that this new endeavour is in the hands of the few.

One of these, Alfa Plastics, Ltd., of 20, St. Dunstan's Hill, London, E.C.3, has recently forwarded us one of the first batches to come from its moulding machines.

Of their colourful beauty there can be no doubt and we have taken special pleasure in reproducing them in colour, with an apposite background.

Regarding lustre, we are of the opinion that this compares very favourably with that of the natural precious stones in their cut state, especially so in the case of light colouring such as that of "aquamarine." The refractive index of aquamarine normally ranges from 1.57 to 1.60; that of topaz from 1.61 to 1.64; but for diamond it is as high as 2.40. Even in the case of the polystyrene "diamond," however, the resemblance is remarkably good, especially when we remember that high-quality colourless topaz, white sapphire, zircon and similar stones, have often been used in the jewellery trade as substitutes for true diamond on account of their high lustre, although readily distinguishable from diamond by lower hardness. The glass "paste" commonly employed for artificial gem stones normally had a refractive index of 1.65, but reaches 1.8 to 1.9 with considerable loss in hardness.

A great amount of thought and experiment has gone into this development by Alfa Plastics, Ltd., which has taken upwards of two years. Polystyrene, with the highest refractive index (given variously as 1.58 to 1.67 according to sources) of all plastics, was chosen and the moulding is carried out by a process very similar to injection moulding.

The first problem to overcome was to produce cavities with exceptionally high optical polish, which included, among other things, a polishing process specially evolved for the purpose. Furthermore, the chromium plating was carried out at an extremely low specific load with especially shaped electrodes.

The moulding itself requires a special cycle owing to the inability to overcome sinkings and bubbles when utilizing minimal-sized gates and the usual injection moulding technique. Although it slowed down the output somewhat, this special cycle was absolutely necessary.

A great advantage of the plastic "gems" is that, in addition to ease of fitting with normal claws, they can be press-fitted because of their mechanical strength, or, again, may be fastened by pushing a little heated pin into the reverse. This latter process, which takes advantage of the thermoplasticity of the polystyrene, greatly advances the possibility of both mass-production and mass-usage.

In congratulating Alfa Plastics, Ltd., on this new endeavour we acknowledge with thanks the help given us in compiling the above notes.

A flashing stream shall wash thy feet
With ruby, sapphire, chalcedon.

Two scenes at Ealing Studios when making the film "Scott of the Antarctic." The use of plastic artificial snow is described in the article on the opposite page.

Plastic artificial snow provides a realistic "atmosphere" for filming "Scott of the Antarctic" at Ealing Studios.

Weather Report

It Will Continue Very Hot With Snow Falling at Ealing Studios

UNTIL quite recently, film studios have always had difficulty in portraying snow scenes. The depicting of falling and ground snow created many headaches. For the ground effect, plaster-of-paris in conjunction with salt has been used in the past where footprints were not required, but until the advent of plastics there was no suitable medium for depicting scenes of falling snow. Then the film industry used ground-up scrap methyl methacrylate for this purpose, but it was unsuitable for snowstorms and did not create quite the right effect.

The Rank organization have been preparing for the past three years to make a film of Scott's expedition to the Antarctic, and, as nearly every scene was a snow scene, some alternative to plaster-of-paris and salt was required. The Special Effects Department of Ealing Studios contacted Expanded Rubber Co., Ltd., who produced an experimental snow made from light-density urea formaldehyde resin, which was called "Fuff" by the film technicians. Various densities were tried out between about 3 lb. and $\frac{1}{3}$ lb. per cubic ft., and it was eventually decided that material having a density of $\frac{1}{2}$ lb. per cubic ft. was the most suitable all-round snow. This material, produced by Expanded Rubber in blocks measuring 4 ft. by 2 ft. by $4\frac{1}{2}$ ins., was found suitable for making footprints and also falling snow.

The falling snow was made by grinding up large blocks in a mechanically operated wide-mesh sieve. The size of the mesh, and the speed of the motor operating, determined the actual snowflake size. This was considered rather important by Ealing Studios as the snowflakes normally experienced here are dissimilar to those found in the Antarctic.

It has been reported in the Press that location shots for the Scott film were made in Antarctica as well as Switzerland and Norway, and as the film is in Technicolor it was of the utmost

Low-density urea-formaldehyde resin is prepared in slabs of convenient size.

importance to obtain an identical colour match. From reports given by the studio technicians, it will be impossible for film audiences to detect where studio sets begin and location shots finish.

At one stage in the film 80-miles-an-hour blizzards were created which consumed 700 lb. of snow in seven minutes, but fortunately it was not necessary to retake these scenes more than once! From the accompanying "stills," which were actually taken in the studios, it will be seen that it is impossible to detect whether this is the real thing or otherwise.

It is expected that large quantities will be used for Christmas decorations, displays, etc., and it is possible that the higher-density material (about 3 lb. per cubic ft.) will be useful for insulation. The latter has not, as yet, been manufactured on a large scale. A further use envisaged for "Fuff" is the packing of glassware and scientific instruments. It should prove a boon to exporters of glassware, as they will have a sure medium for packing without risk of breakage.

The advantage of using "Fuff" for packing scientific glassware is that it can be placed as a block in a container and then the glass pressed into the "Fuff," thus ensuring that it is firmly packed. A smaller layer of "Fuff" is then placed over the top to ensure complete protection of the glass.

One further use of "Fuff" might be in the chromatographic field, as it has been found to separate certain dyestuffs, but up to the present no large-scale tests have been conducted in connection with this.

Acknowledgements

The studio photographs are reproduced by permission of Ealing Studios, Ltd., who have just finished making the film "Scott of the Antarctic." This film is a Michael Balcon production, directed by Charles Frend.

RESIN-BONDED DIAMOND WHEELS

(Continued from page 454.)

powders with resin powders, e.g., Brit. Pat. 548,536 (1941), which has already been mentioned.

Although natural resins, e.g., shellac, have been used for bonding abrasive grain probably since about 1820, they are not mentioned in the patent literature until a relatively recent date. Natural rubber is usually mixed with sulphur and the abrasive grain, and vulcanization takes place during moulding, e.g., Russ. Pat. 45,181 (1935) and U.S. Pat. 2,063,685 (1935).

Synthetic rubbers were not proposed for binding until about 1939, when polychloroprene was proposed in U.S. Pat. 2,241,433; a "Buna" type synthetic rubber, Perbunan, was suggested in U.S. Pat. 2,384,684 (1940). These synthetic rubbers are vulcanized just the same as for natural rubber, and they are superior in heat resistance to the natural material.

World's Industry Employs Plastics

GENERAL ENGINEERING

Metal bonding.—American practice in bonding thin metal sheets by synthetic resin adhesives is reviewed by F. A. Westbrook, who deals with investigations carried out by the Resinous Products and Chemical Co., Philadelphia. A bevelled lap joint increases strength. ("Machinery Lloyd" (Cont. edit.), 1948/June/26/52.)

Cutting and shaping.—The methods used by artist Litzi von Miklos in shaping plastics by electric hand tools are described in "Science Illustrated," 1948/Apr./92.)

Lubrication studies. — Transparent models of journal bearings made in acrylic resin assist in the study of lubrication phenomena. They proved helpful for studying the groove design for a ring-oiled bearing and for finding the proper location for the window in a wick-oiled bearing. ("Mechanical Engineering," 1948/July/589.)

Densified wood made with Bakelite resins are described in new booklet issued by Bakelite Corporation, 300 Madison Avenue, New York, 17. Application in industry include moulds and dies, extension turntables, textile picker sticks, spool ends and shuttles. (Review in "Mechanical Engineering," 1948/July/617.)

Comparisons with metals.—R. G. Chollar compares metals with plastics, as regards specific gravity, comparative costs, comparative hardness (based on Tukon Microhardness tests), shock resistance, tensile strength, thermal expansion, thermal conductivity, heat resistance, dielectric strength, modulus of elasticity, damping characteristic, creep and cold flow, weathering and surface effect. The properties of moulded and laminated phenolics, glass laminates, ureas, vinyl-chloride acetates, methyl methacrylates, polystyrene, polymides and cellulosic plastics, are compared with steel, aluminium, magnesium and zinc. (A.S.T.M. Bulletin, 1948/May/80.)

Power transmission belts.—Nylon-reinforced V-belt (United States Rubber Co., Rockefeller Centre, New York) is said to have twice the strength and four times the average life of conventional V-belts. A series of nylon cords are covered with a special synthetic-rubber compound and so made resistant to heat and oil. ("Machine Design," 1948/June/180.)

Reinforced joints.—A second survey on the characteristics and configurations of reinforced plastic joints has been prepared by R. J. Francis. About 20 joints used in assembling reinforced plastics are shown with same thicknesses for parts made of material with identical moduli of elasticity. ("Product Engineering," 1948/June/134.)

Laminates.—Cheaper surface and structural laminates may be produced by the continuous coating and impregnation of rolls of many different sheet materials, as reported by C. W. Armstrong. ("Product Engineering," 1948/June/140.)

Crankshaft bearings.—E. Gilbert reports that thin layers of synthetic resin wrapped around and bonded to crankshafts gave satisfactory performance when running in steel bearings in an aircraft engine or ship's Diesel engine; results on road-vehicle engines were less satisfactory. Pressures of 3,500 lb./sq. in. could be supported. ("Motortechn. Zeitschrift," 1948/Aug./58.)

ELECTRICAL

Cable coverings.—H. Heering, H. Puell and L. Drewitz report on a new method to determine the permeability of cable - covering materials to water vapour. It is stated that the method developed is extremely simple and reliable. ("Kunststoffe," 1948/Mar./49.)

Dielectric behaviour.—Dr. Gast reports on some physical demonstrations on the dielectric behaviour of plastics, taken from his course on "dielectrica" at the Technical University, Darmstadt. ("Kunststoffe," 1948/Mar./53.)

Coil insulation.—A new method of insulating magnetic coils with plastic sealing sleeves involves a dilator solution in which the plastic is immersed from two to four hours. When expanded again to half its normal size the sleeve is placed over the coil. In drying it shrinks to smaller than its original size, thus forming a tight fit. ("Materials and Methods," 1948/July/65.)

Cable covering.—A new type of aluminium mine cable (United States Rubber Co.) is covered with a neoprene rubber compound which resists oils, acid and water. ("Engineering and Mining J.," 1948/June/112.)

Assembling by screws.—H. Turnwald suggests the use of square holes in moulded plastics into which an ordinary screw can cut its thread, thus solving the problem of fixing small screws to moulded components. ("Kunststoffe," 1948/May-June/105.)

Rubber.—Electrically conductive rubber has been developed by U.S. Rubber Co. It has a long expectancy of life when heated up to 150 degrees F. (about 10,000 hours), but life drops to about 100 hours when heated up to 250 degrees F., which is still a remarkable performance. Various technical applications are described. ("Materials and Methods," 1948/July/60.)

Electrical insulation failure.—J. Leutritz concludes that functional failures of electrical, electronic and communication equipment, which were so frequent in the South-west Pacific during the war, were not essentially due to fungi. Moisture, moisture and dust, and combination of moisture, dust and fungi, however, will cause electrical failure. Elimination or mitigation of moisture difficulties automatically controls fungus. (A.S.T.M. Bulletin, 1948/May/88.)

MISCELLANEOUS

Dishes and cups of "Melmac" (American Cyanamid Co.) have been tried out in an American state hospital; breakages in nine months equalled a day's breakage for china. ("Science Illustrated," 1948/Apr./51.)

Heat and sound insulation.—W. Nicholls discusses advantages and applications of plastics to thermal insulation and acoustic absorption. He refers in particular to sandwich constructions. ("Machinery Lloyd" (Cont. edit.), 1948/July 10/62.)

Lacquers.—Specific tests (tension in steel rod of 40 kg./sq. mm. with maximum error of plus or minus 10 per cent.) with brittle lacquers indicate preference for a composition of 100 cubic cm. alcoholic amyl acetate, 50 grams colophony, and 5 grams celluloid. ("Metallurgia," 1948/Apr./290.)

Boat Construction.—D. F. May reviews the progress made since 1943 in the use of glued laminates in the construction of small boats. Laminates have also been used for the construction of water tanks. (A.S.M.E. paper 47-A-68, abstracted in "Mechanical Engineering," 1948/July/634.)

Degree of curing.—For investigating the degree of curing of a component of a thermosetting resin, K. H. Hauck places it in an oven with uniform increase of hardness. Sensitive optical and photo-electric measuring devices allow changes in the wall thickness of the sample to be read direct. Characteristic curves are obtained for differently treated samples. (" Kunststoffe," 1948/May-June/99.)

Laminate glues.—Progress in the production of plastic glues and their applications for laminates are surveyed by H. Saechtling and K. H. Mielke. Laminated materials, according to American usage, are grouped as contact-laminates, low-pressure laminates, and high-pressure laminates. (" Kunststoffe," 1948/May-June/85.) W. Kuech and K. Berger have determined the time of application of plastic glues by measurements of viscosity. (" Kunststoffe," 1948/May-June/95.)

Flexible diaphragms.—The design and application of non-metallic flexible diaphragms has been surveyed by J. H. Swartz. Burst strength, flexibility and fatigue resistance are the main physical requirements. Various polymers in compounded and uncompounded state may be employed.. (" Machine Design," 1948/June/153.)

Insulation material.—A snow-white plastic-foam insulating material, made by United States Rubber Co., Rockefeller Centre, New York, is supplied in either shredded or block form. The shredded material has a density from 0.8 to 1 lb./cubic ft.; block insulation weighs 0.8 to 1.5 lb./cubic ft. (" Machine Design," 1948/June/176.)

Hobbing.—A new hobbing press with a pressure capacity of 500 tons has been developed by E. W. Bliss Co., 450 Amsterdam Av., Detroit, 2. The press speed is 2 ins. per minute. The press frame consists of two steel castings rigidly mounted on four heavy steel tie-rods. (" Business Week," 1948/June 26/58.)

Dipping racks.—A viscous liquid, Enthonite 101 (Enthone Inc., 442, Elm Street, New Haven, Conn.) has been developed for protecting the dipping racks used in acid and chromium plating solutions. The coating is also recommended for work holders. (" Business Week," 1948/July 10/55.)

Phenolic adhesives.—Two new modified phenolic liquid adhesives for bonding metals, thermosetting plastics, wood, fabric, etc., have been made known. General Electric adhesives 12507 and 12508 have high shear and tensile strength and exceptional resistance to water, kerosene and mineral oils. When used, the plastics have no need to be sanded. (" Machinery," New York, 1948/June/190.)

Nylon bearings.—Newest use of mouled nylon (Machinecraft Inc., Whitman, Mass.) is for wheel bearings in prams. This material does not require lubrication, and is said to outwear metal. (" Materials and Methods," 1948/July/63).

Tube covering.—Metal tubes for furniture, guard rails, etc., are covered with a 1/32-in. coating of coloured plastics (Samuel Moore and Co., Mantua, Ohio, U.S.A.), applied by extrusion process. (" Materials and Methods," 1948/July/63.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

The Dielectric Properties of Plastics

THE need for further research into the dielectric properties of plastics for applications in telecommunication equipment is stressed in the report of the Telecommunications Research Committee's Working Party on Properties of Materials, which forms part of a recent official publication. ("The Fundamental Research Problems of Telecommunications," H.M. Stationery Office, 1s. 6d.) It is stated particularly that the development of new techniques have benefited repeatedly in the past as a result of materials having useful properties which became unexpectedly available. For example, the original synthesis of phenolic resins by Dr. Baekeland and the polymerization of ethylene by I.C.I. were both carried out without any particular regard to the requirements of the telecommunications industry. The first of these materials revolutionized the design of all telephone instruments; the second has facilitated the development of cables and other apparatus for use in high-frequency circuits.

The importance of plastics in bulk form for telecommunication applications, states the present report, first became apparent with the polymerization of moulding resins of the phenol-formaldehyde, urea-formaldehyde and similar types. Polymerization of other chemical compounds has also resulted in materials having low electrical loss, and other characteristics, which make them very suitable for use in a high-frequency circuit; polythene is one particular instance. Improvement of these materials would be assisted by further work on the theory of dielectrics and a better knowledge of the factors governing their deterioration and also their limitations in service.

The development of new materials will arise largely from chemical synthesis. Aspects of application to be particularly studied are: (i) Intrinsic electric strength and the effect of discharges; (ii) dielectric constant, loss, and absorption; (iii) thermal stability; (iv) mechanical properties.

The intrinsic electric strength expected from the molecular structure of the material may be 10 to 1,000 times greater than the electric strength realizable in practice with present technique. The industrial importance of closing the gap between intrinsic and realizable electric strength is evident, because this would lead to an increase in the voltage rating of capacitors and cables.

The residual dielectric loss, after the supposed elimination of impurities, cannot be precisely predicted from chemical composition. At the moment the discrepancy is assumed to be due to remaining impurities resulting from manufacturing conditions.

Thermal stability and mechanical properties are often of paramount importance. Inadequacy in one or both may impose restrictions on the use of materials which have good electrical characteristics. Materials which have a low softening temperature, such as polystyrene, cannot be used in cables or components which are subjected to heat. Recent endeavours to get improved behaviour at higher temperatures have resulted in polyglass, special varieties of polystyrene and polytetrafluorethylene (poly-f), but it is considered that a dielectric capable for use at 150 degrees C. would find many immediate applications.

Mechanical properties are of the greatest practical importance when moulding apparatus parts; they also concern the subsequent strength or slow distortion of moulded parts. Further, a better understanding of the phenomenon of impact breakage is needed.

As a point of special interest, several research workers have recently reported the generation of small direct voltages when cables insulated with polythene and similar materials are distorted; this proves troublesome when such cables are used in certain measurements.

The difference between the intrinsic

and industrial electric strengths has been shown to arise in all practical cases from ionic discharges which may be so inconspicuous as to be unsuspected, and the mechanism of this phenomenon is now being studied.

As a result of both theoretical and experimental work in a number of laboratories, the explanation of dielectric constant and loss in terms of molecular structure is progressing. The Debye-Frölich dipole theory has been successfully extended to cover materials in which (a) interaction of adjacent dipoles is important; (b) distribution of relaxation times exists; and (c) the loss angle is independent of frequency. Other recent experimental work has been concerned with the effect of impurities in increasing the dielectric loss in low-loss polymers, of which polythene is one of the most important examples.

Research on dielectrics may be of two kinds. There is the analytical approach, which consists of the accurate measurement of electrical and mechanical properties and the correlation of these with the micro- and macro-molecular structure, thus leading to a better understanding of the behaviour of the dielectric in practice and the improvement of existing materials by modifications within the limits of their chemical structure. There is also the synthetic approach, which concerns the chemical synthesis of entirely new materials, with structures which would be expected on theoretical grounds to lead to new combinations of electrical and mechanical properties; this is a course which was followed with some success by the German plastics industry.

The Electrical Research Association has comprehensive programmes of work covering most of the items referred to. With regard to certain aspects, notably, those closely associated with intrinsic electric strength and the effect of discharges, the E.R.A., states the present report, is probably as far advanced as any organization in the world. The National Physical Laboratory has made measurements of the electrical and mechanical properties of a wide range of industrial plastics and also of plastics of comparatively known composition prepared by the Chemical Research Laboratory.

Used as coatings, i.e., as varnish or lacquer, the function of plastics is directed towards (a) maintenance of high insulation resistance, especially under humid conditions; (b) prevention of corrosion of metal chassis, metal containers, components, etc; and (c) prevention of fungus growth and swelling or warping of insulating materials. Impregnants also serve some of the above functions. Impermeability to water is a desirable property which is unlikely to be wholly obtained.

Traces of residual solvent as regards the use of impregnants may lead to corrosion, and an impregnant which is solvent-free is, therefore, desirable; a cross-linked hydrocarbon resin, requiring little or no catalyst, may be an answer to this problem. There is also the possibility that many requirements may be met by the use of silicone varnishes, but research work is necessary to produce a material which can be polymerized in situ to have the requisite mechanical and electrical properties in its final form.

Useful information regarding the behaviour of existing materials in service under extreme conditions of temperature and humidity has been collected during the past few years by the Chemical Department of the Ministry of Supply, and the mechanism of diffusion of water and gases, including diffusion through polymeric materials, is being studied in the Universities.

One group of elastomers of particular interest in telecommunications is that of the silicone rubbers. The potentialities of materials of the silicone class are great, if only because a new field in chemistry is being opened up. The outstanding advantages claimed for materials of this class are heat resistance and water repellency. Heat-resistant covered wires, with a silicone rubber cover, are much more flexible than those with ceramic coatings. A British Panel is endeavouring to evaluate samples from the U.S.A.

Book Reviews

Plastics in Handicraft. By. P. W. Blandford. Pp. 167. Chapman and Hall, Ltd. 15s. net.

Although we remember that handicraft plastics has been carried out in schools for at least 10 years, books on the subject have rarely displayed great ingenuity or, indeed, the requisite details of exposition, even for the youthful pupils. Not that the present book is a great advance on previous ones on this subject, which is perhaps one of the most attractive of mechanical methods of teaching the young to use their hands. Following a short description of the properties of plastics, it does, however, go quite adequately into the methods of manipulation of those plastics available for the purpose, namely, casein, acetate and acrylic sheetings, and cast phenolics. This includes details of the simple machinery necessary, and the arts of cutting, shaping, drilling, turning, bending, cementing, fastening, carving, inlaying and finishing. There are additional chapters on "hand-tool projects," suitable for what the author calls elementary and advanced pupils.

We should like to have seen included some attempt at teaching the art of engraving. Surely this, which is a much finer art than that of sticking one piece of plastic to another or merely cutting out sheets with a saw to a predetermined design, would give play to much greater ingenuity and individual spirit and taste. We should also like to see in each school one of those amazing little hand tools, such as are made by Desoutters, Ltd., and others, and the pupils using it almost as easily as they do pencils.

If we may make one small criticism it is that the author uses certain chemical phrases, which, to say the least, are curious. What would a chemist think of the following, on p. 23: "Details of manufacture are not available. Perspex is described as a polymerized methyl methacrylate prepared from acetone in the cyanhydrin"? Also on p. 49, when writing of cast resin: "The raw resin is a thick syrup, which is the same as the finished material, except that it has not gone through the final process (called polymerization). This final process is the drying out of the water chemically contained in the syrup."?

Experimental Casting Plastics. By Thomas Dickinson. Pp. 30. Plastics Research Co., Alhambra, California.

The casting of plastics is one of the more recent manufacturing techniques. It requires very little and inexpensive equipment, and is, therefore, of considerable interest to smaller factories and workshops. Mr. Dickinson's booklet is the first of its kind, and although the information provided would not be of much value to the expert, it should be quite valuable to newcomers. The four chapters deal with patterns, moulds, casts and miscellaneous hints, such as eliminating air bubbles, heating equipment, lubricants for moulds, etc. The chapter on moulds describes, among other types, elastomeric moulds made from specially compounded p.v.c., a technique which has already been described in "Plastics" (March, 1948, p. 113).

Palmer's Private Companies: Their Formation and Advantages. 40th edition. By J. Charlesworth. Pp. 100. Stevens and Sons, London; 3s.

Private companies have for many years been of great service in fostering the development of commerce and industry by enabling business to be conducted without unnecessary risk to the person who engages in it; likewise with freedom from hampering formalities. Up to the end of 1946, out of 213,915 companies on the register no fewer than 200,743 were private companies, with a combined paid-up capital of £1,923,000,000. This particular book has been continuously in demand for nearly 60 years. The present edition has been brought up to date, and includes reference to the provisions of the Companies Act, 1947.

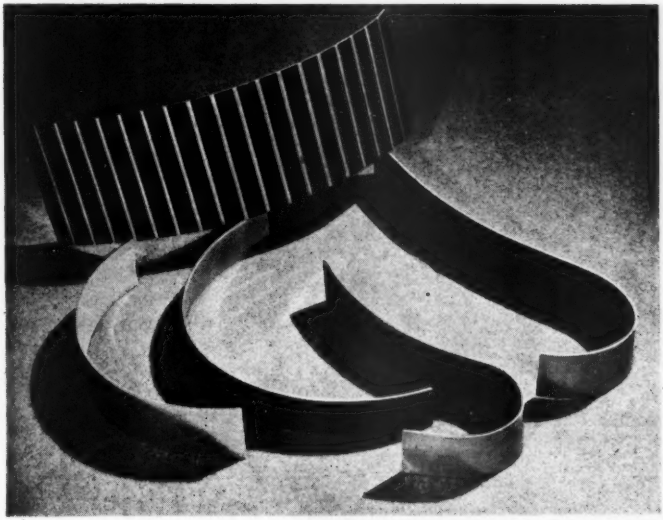


Fig. 1.—One of the advantages of this new laminate is that it may readily be formed to curves of small radius.

Decorative Laminate with an Aluminium Core

AN entirely new type of "Warerite" decorative sheet, having an aluminium core, has been successfully developed in the laboratories of Bakelite, Ltd. This new material offers two outstanding advantages. For the first time it becomes possible to form decorative laminates to relatively small radii, so opening up further important outlets in interior decoration and in the construction of domestic fitments such as draining boards and sink units. The second advantage, which for certain applications is even more important, is that the material is capable of passing the "non-inflammability" test laid down in Section 7 of B.S.476 (1932).

The new material may have a core of pure aluminium or aluminium alloy, the "Warerite" facing being applied either to both sides or to one only. Technically, it is possible for any thickness of core to be employed, although for production purposes it has been decided to concentrate on two standard thicknesses. One of these is B.A.60 half-hard 14-gauge (0.08 in.), which is adopted for the wall-panel type of application; the other core material is 20-gauge (0.036 in.) pure aluminium.

Based on 20-gauge aluminium, the material is 20-gauge (0.036 in.) pure 0.02-in. phenolic laminate, so that the total thickness is 0.076 in. The decorative surface may be black or any standard dark colour, wood grain, or pattern. This 20-gauge core is pure soft aluminium, which enables the sheet to be bent or formed readily. The resultant shapes show less tendency to revert to the original flat sheet than do sections in ordinary grades of paper laminate.

The standard inflammability test is severe to the degree that no other decora-

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Fig. 2 (left).—The non-inflammability test laid down in B.S. 476 (1932) is severe upon a sample of normal plywood. (Sample I.)

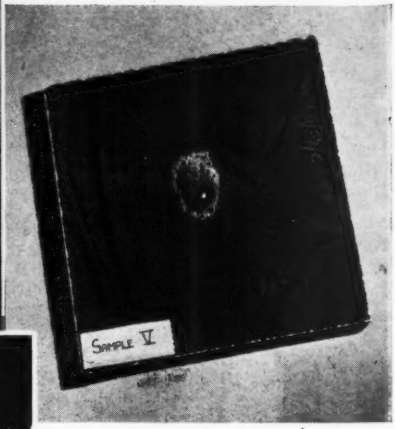


Fig. 3 (above).—The resistance to inflammability of asbestos-cored phenolic laminate is very superior to that of plywood, although considerable blistering is apparent. (Sample V.)

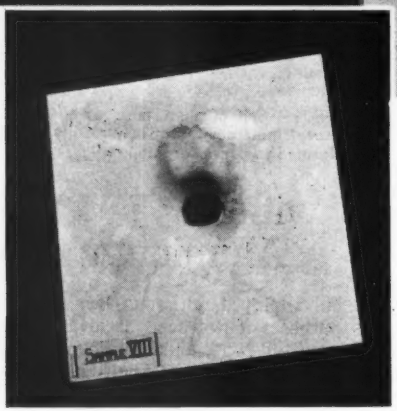


Fig. 4 (left).—Similar results are obtained when a urea decorative facing is applied to the asbestos core; the surface has been marred, but there is little other damage. (Sample VIII.)

tive plastics material is capable of achieving a non-inflammable classification. The test requires specimens 6 ins. square to be subjected to a standard flame impinging on the material at an angle of 45 degrees. When subjected to this test, normal phenolic veneers and wall panels are rejected, but both phenolic and urea-faced metal-cored materials achieve a "non-inflammable" classification. What this classification means in practice is brought out by illustrations of some of the test specimens.

The degree of charring with plywood is shown in sample I; damage done to asbestos-filled laminates with phenol or urea facing, in samples V and VIII. The effect of the metal core is seen in samples VI and IX, which have successfully withstood the test conditions. Not only is the light-alloy-cored sheet superior to the other test specimens illustrated, but it also withstands flame better than sheets bonded with phenolic resin and filled with glass fabric or asbestos fabric.

Application has been made for a patent to cover the technique of producing this aluminium-cored material, which, of course, is quite distinct from the heat-resistant "Warerite" material already

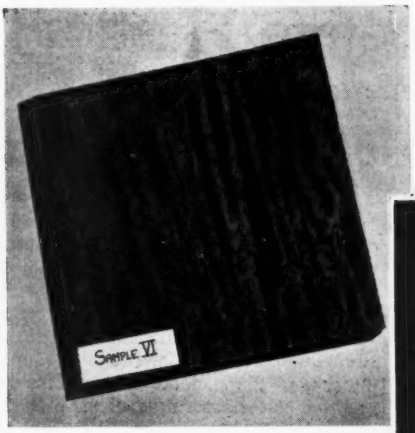


Fig. 5 (left).—With a phenolic laminate on aluminium core, the standard inflammability test produces no ill effect whatsoever. (Sample VI.)

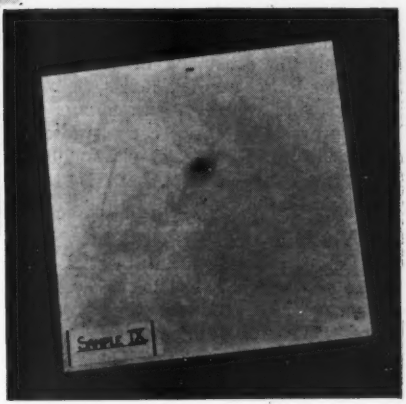


Fig. 6 (right).—An aluminium core in place of asbestos for urea decorative sheet, other conditions being identical, reduces damage to the negligible level shown here. (Sample IX.)

produced for bar tops and table tops with the object of enabling them to withstand contact with burning cigarettes. These "blisterproof" grades actually incorporate an aluminium foil immediately below the surface sheet, the object of which is to conduct the heat away sufficiently rapidly to prevent a local temperature rise at the point of contact with a cigarette, which might otherwise be capable of raising a blister.

Increased Stability

Although the degree of non-inflammability obtained by the new material is of outstanding importance for the decorative treatment of ships, railway trains and aircraft, there are other technical advantages of comparable importance for normal decorative use. For instance, there is a considerable increase in stability. Under conditions of varying humidity normal laminates may exhibit a tendency to buckle between fixing points. Tests which have been carried out on the new aluminium-cored material, however, show no bowing after several weeks' immersion in water.

Another point of interest to the designer is that unusual decorative effects can be obtained by machining away the plastics facing, thus revealing the metal core. This aspect offers useful possibilities for obtaining unusual decorative effects without the complications attendant upon introducing two independent types of material.

For production purposes, it has been necessary to concentrate on two standard thicknesses of cored material; this is a limitation of production economics and not of technical practicability, for any thickness of core can be employed. Assuming sufficient quantities are required, and that cores can be provided in the required dimensions, it is possible for this new material to be manufactured using aluminium-cored materials supplied by customers.

This new aluminium-cored decorative laminate has been placed on the market by Warerite, Ltd., of Ware, Herts.

Cellulose Acetate Plastics

XV.—Some General Properties

By
Vivian Stannett

THE general weathering and ageing properties of cellulose acetate plastics have already been described in this series. It is now proposed to discuss an associated group of properties, including the resistance of the plastic material to chemicals, acids, alkalis, solvents, and water. These factors are all of great importance when considering the possible behaviour of a plastic during its service use.

Resistance to Chemicals

Taking into consideration some of the end uses of cellulose acetate plastics, such as the packaging of various chemical and pharmaceutical products, this property is of considerable interest. It should perhaps be emphasized that the best test of the resistance of the plastics to a particular chemical is to actually try it out under conditions as near as possible to those under which it is intended to be used. Published tests, or accelerated tests, can only give an indication of its possible behaviour. Furthermore, the time of contact involved in actual practice is often extremely long, running into several years in many cases, and this should be borne in mind when considering the results of simple laboratory experiments.

An additional point is that although the surface of the plastic may be gradually attacked or marred by the reagent, the practical serviceability of the plastic may be virtually completely unimpaired. This point has been well emphasized by Delmonte,[1] who measured the effect of acids on a number of plastics by determining the change in shear strength which took place after various periods of immersion. The shear strength was determined by a simple punch and die method[2] and the results reported as the percentage of the original shear strength. Some results for several plastics, including cellulose acetate, showing the reduction in shear strength which occurs after 700 hours' immersion in a number of acids and alkalis of various strengths are given in Table 1.

Fig. 1 shows in graphical form the effect of time of immersion in the reagent against the percentage loss of shear strength. It was found that a complete loss (100 per cent.) of shear strength was caused by 6.25N caustic soda solution in the case of cellulose acetate in less than 250 hrs. Delmonte also studied the effect of conditioning the sample on the rate of attack. The results for cellulose acetate in the case of 4.4N caustic soda are shown in Fig. 2. It can be seen from this graph that although the speed of attack is changed considerably, the final result was unaltered.

A different approach was used by Kline, Rinker and Meindl.[3] These workers cut strips approximately 3 in. × 1 in. × ⅛ in. from plastic sheeting

Table 1.—Percentage of Original Shear Strength retained after 700 hours' Immersion.

	Nitric acid		Sulphuric acid		Hydrochloric acid		Caustic soda	
	1.12N	6.55N	4.3N	11.05N	1.04N	12.1N	1.39N	9.3N
Laminated phenolic, paper base	42	10	68	64	36	8	45	56
Cellulose nitrate	75	61	77	73	70	0	70	59
Cellulose acetate	0	0	52	57	92	88	78	89
Polymethyl methacrylate	80	69	97	93	42	0	32	11

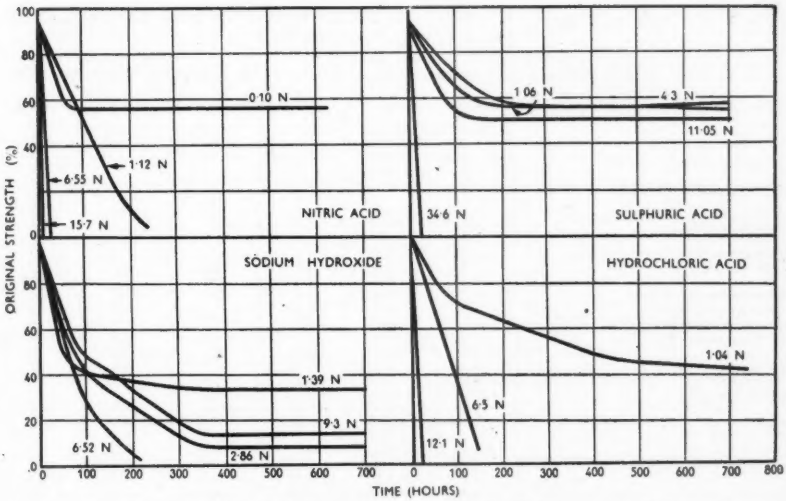


Fig. 1.—Effect of acids and alkalis on shear strength of cellulose acetate (Delmonte[1]).

including cellulose acetate, and totally immersed the specimen in 60 ml. of the appropriate reagent. Then the changes in weight and dimensions which took place after seven days' immersion were measured both directly and after reconditioning the samples. In addition, the changes in the appearance of the plastic strip was noted. These results in the case of cellulose acetate are given in Tables 2 and 3. For the comparative figures in the case of the several other plastics tried, reference must be made to the original paper in which very complete figures are given.

Effect of Solvents

The resistance of plastic materials to solvents has been studied in detail by Delmonte.[4] He used a similar approach to this problem as he had previously used for acid and alkali resistance. It will be recalled that this involved the measuring of shear strength of samples after various times of immersion in the reagent concerned. As before, the shear strength was determined[2] by measuring the load required to force a small punch and die through a given thickness of material. The results are recorded as the percentage of the orignal shear strength of the sample, a thickness of $\frac{1}{16}$ in. being used in most cases.

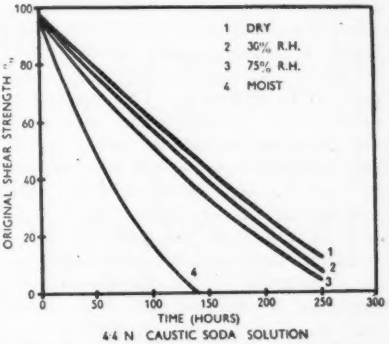


Fig. 2.—Effect of conditioning on rate of attack of caustic soda solution on cellulose acetate sheet (Delmonte[1]).

All samples were conditioned before testing by heating in an oven with air circulating at 122 degrees F. This preconditioning was found to have a pronounced effect on the speed and intensity of solvent action, and an example of this

Table 2.—Percentage Changes in Weight, Length and Thickness for Cellulose Acetate Sheeting. (Kline, Rinker and Meindl[3].)

(a) After immersion for seven days in chemical reagents at 25° C.
(b) Under the same conditions, but with subsequent exposure for 28 days to air at 25° C. and 50% relative humidity.

	Percentage change in weight		Percentage change in length ±0.03		Percentage change in thickness ±0.08	
	(a)	(b)	(a)	(b)	(a)	(b)
Sulphuric acid 30%	0.8	− 3.4	0.17	− 0.2	0.0	− 3.8
Sulphuric acid 3%	3.8	− 0.7	1.03	− 0.7	2.3	0.0
Nitric acid 10%	D	A	A	A	A	A
Hydrochloric acid 10%	11.0	− 9.9	1.2	− 0.1	11.7	0.7
Acetic acid 5%	6.5	0.3	1.6	− 0.6	4.2	1.9
Oleic acid	0.1	0.2	0.04	0.0	0.0	0.0
Sodium hydroxide 10%	73.0	−18.0	1.1	−34.0	85.0	80.0
Sodium hydroxide 1%	3.0	− 8.3	1.3	− 1.3	1.9	− 6.4
Ammonium hydroxide 10%	5.8	−38.0	−2.4	−25.0	39.0	7.1
Sodium carbonate 2%	2.6	− 2.5	0.73	− 1.0	1.5	0.0
Sodium chloride 10%	2.8	− 0.2	0.83	− 0.2	1.5	0.0
Hydrogen peroxide 3%	4.5	− 1.5	0.99	− 0.9	3.0	1.5
Distilled water	4.6	− 0.7	1.2	− 0.7	2.8	0.8
Ethyl alcohol 50%	25.0	−11.0	1.3	− 6.7	43.0	21.0
Ethyl alcohol 95%	95.0	−13.0	−0.20	−12.0	38.0	20.0
Acetone	S	A	A	A	A	A
Ethyl acetate	S	A	A	A	A	A
Ethylene chloride	112.2	−12.0	24.0	6.9	43.0	A
Carbon tetrachloride	2.2	− 0.3	0.18	0.0	0.0	− 0.8
Toluene	1.2	− 4.2	0.38	− 0.9	4.9	− 0.4
Gasoline	− 0.3	− 0.2	0.05	0.0	0.0	− 0.4

A.—Action of reagent on sample made measurements of dimensional changes impracticable or impossible.
D.—Decomposed. S.—Dissolved.

effect is given in Fig. 3, which shows the effect of preconditioning on the rate of attack of acetone on cellulose acetate sheet at 70 degrees F. The speeding up of the attack by the presence of water in the cellulose acetate is readily understandable and is in line with the "opening up" of this type of material by water and certain other reagents. An example can be found in the pretreatment of cellulose itself before esterification, etc. As a matter of interest, the effect of conditioning of cellulose acetate at various humidities on the shear strength is given in Fig. 4.

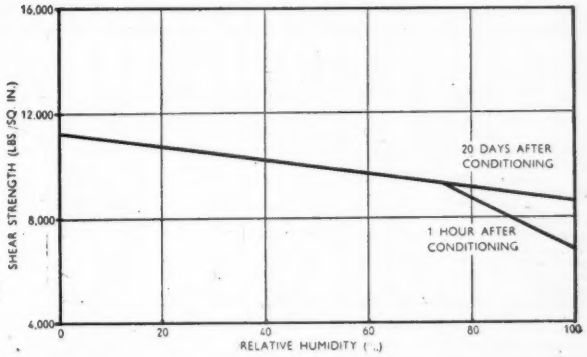
The effect of temperature on the rate of attack of acetone on cellulose acetate is shown in Fig. 5. As would be expected, action is considerably retarded by lowering the temperature.

The effect of various solvents and non-solvents on cellulose acetate sheet is shown by the loss of shear strength versus time of immersion curves presented in Fig 6. Similar curves for several other plastic materials can be found in the original paper of Delmonte. The most interesting are the curves for non-solvents. The path of the curve of a plastic material immersed in one of its solvents could be anticipated, although the rate of attack is interesting and useful if a solvent or mixture of solvents is required for a limited attack on the plastic, as, for example, for scratch removal or surface polishing. In the case of non-solvents, it can be seen that the

Table 3.—Effect on Cellulose Acetate Plastics after Immersion for seven days in Chemical Reagents at 25 deg. C. (Kline, Rinker and Meindl[3].)

Reagent	Effect
Sulphuric acid 30%	Crazed, softened
Sulphuric acid 3%	Swollen
Nitric acid 10%	Decomposed
Hydrochloric acid 10%	Decomposed
Acetic acid 5%	Swollen
Oleic acid	None
Sodium hydroxide 10%	Decomposed
Sodium hydroxide 1%	Surface attacked
Ammonium hydroxide 10%	Opaque, soft
Sodium carbonate 2%	Swollen
Sodium chloride 10%	None
Hydrogen peroxide 3%	None
Distilled water	None
Ethyl alcohol 50%	Partly dissolved
Ethyl alcohol 95%	Partly dissolved
Acetone	Dissolved
Ethyl acetate	Dissolved
Ethylene chloride	Soft, swollen
Carbon tetrachloride	None
Toluene	None
Gasoline	None

Fig. 4 (right).—Effect of conditioning on shear strength of cellulose acetate, two weeks' conditioning at 20 deg. F. (Delmonte[4].)



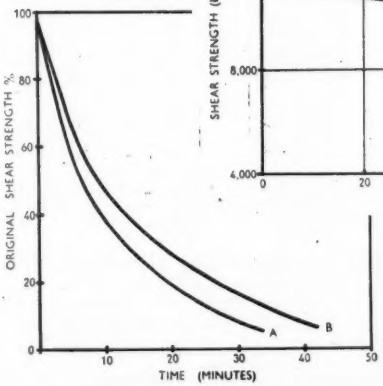


Fig. 3.—Effect of preconditioning on rate of attack of acetone on cellulose acetate sheet. (Delmonte[4].)

A, conditioned one week in water.
B, conditioned one week over calcium chloride.

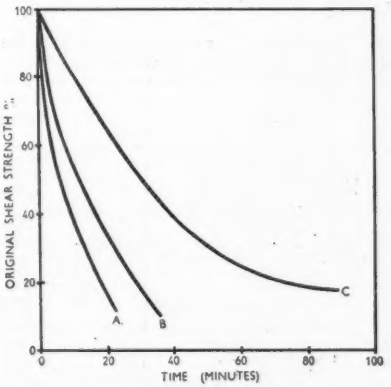


Fig. 5.—Effect of temperature on rate of attack of acetone on cellulose acetate sheet. (Delmonte[4].)

A, 100 degrees F. B, 70 degrees F.
C, 20 degrees F.

shear strength increases gradually with increasing time of immersion, but finally drops off to a steady value.

The particular shear strength finally reached varies from substance to substance, and is presumably simply the value for the fully swollen plastic. In addition, there are some non-solvents—for example, carbon tetrachloride, which produce no effect at all on the shear strength. It was found that these results were unchanged, even after several thousand hours' immersion.

Fig. 7 shows the effect of a combination of solvents on the shear strength reduction, whilst Fig. 8 illustrates the effect of the thickness of the plastic sample on the rate of attack by acetone.

To give a comparison of cellulose acetate with other thermoplastics, Table 4 shows the effect of organic solvents in a conveniently summarized form. When anticipating the behaviour of a plastic material in contact with a particular liquid, the possibility of part of the plastic entering the liquid should also be considered. For example, in the packing of creams, etc., in cellulose acetate containers, some plasticizer or colouring matter may enter the cream, with 'disadvantageous results; in other words, the material can be damaged by contact with the plastic, as well as vice versa. The leaching out of plasticizer from cellulose acetate compositions is accompanied by an eventual embrittlement of the plastic.

Some years ago, details were published[5] of a so-called solvent immunisa-

Table 4.—Effect of Solvents upon Plastics. (Delmonte[4].)

	Ethanol	Methanol	Butyl acetate	Amyl acetate	Ethyl acetate	Butyl alcohol	Acetone	Methyl ethyl ketone	Toluene	Benzene	Carbon tetrachloride	Ethylene dichloride	Cellosolve	Chloroform
Cellulose nitrate	7A	8D	4A	5A	3A	9D	1A	2A	13D	12D	14E	10D	6A	11D
Cellulose acetate	7D	6D	9D	10D	4A	13D	1A	3A	12D	11D	14E	5A	8D	2A
Cellulose acetate butyrate	12D	10D	6A	7A	4A	13D	1A	3A	11C	9C	14D	5A	8A	2A
Polyvinyl chloride acetate..	14E	14E	6B	7B	5B	14E	1A	2A	8D	9D	14E	4A	10D	3B
Polystyrene ..	14E	14E	8A	9A	5A	14E	1A	3A	4A	7A	10A	6A	14E	2A
Polymethyl methacrylate	11D	12D	8A	9A	4A	14E	3A	5A	6A	7A	13D	2A	10A	1A

Most rapid in effect, 1 ; next rapid, 2 ; least rapid, 14. A—Complete dissolving of plastic which enters solution. B—Complete disintegration of plastic with loss of all shear strength. C—Substantial swelling, accompanied by loss of shear strength to a constant value. D—Loss of shear strength to a constant value, no dissolution. E—No effect at all.

Table 5.—Effect of Immersion of Surface-hydrolysed Cellulose Acetate Plastics in Certain Solvents for One Minute. (Based on cellulose acetate of 38 per cent. acetyl content.) (Gearhart[5].)

Solvent	Untreated	Surface hydrolysed for one minute by 3% sodium hydroxide in 75–25 water-ethanol
Ethanol	Slight softening of surface	Unaffected
Ethanol 75%, water 25%	Slight softening	Slow softening
Ethanol 50%, water 50%	Very slight softening	Very slight softening
Ethanol 25%, water 75%	Very slight softening	Very slight softening
Methanol	Slight softening of surface	Slight wrinkling of surface
Butyl acetate	Unaffected	Unaffected
Methyl cellosolve acetate	Surface soft and sticky, dissolving	Unaffected
Carbitol acetate	Soft and partly dissolving	Unaffected
Ethyl lactate	Soft and partly dissolving	Unaffected
Cellosolve	Some soft and slightly sticky	Unaffected
Methyl cellosolve	Some soft and slightly sticky	Very slight softening
Carbitol	Unaffected	Unaffected
Acetone	Surface dissolving	Unaffected
Methyl ethyl ketone	Soft and slightly sticky	Surface pimpled
Ethylene dichloride	Soft and sticky	Surface pimpled
Nitroethane	Very soft and sticky	Surface pimpled
Triacetin	Slightly soft	Unaffected
Methyl phthalate	Slightly soft and sticky	Unaffected

tion of moulded cellulose ester plastics. Although quite successful in reducing sharply the attack of solvents on the plastic moulding, as far as is known to the author, little commercial use has yet been made of this method, except that during the last stages of the war, moulded cellulose acetate phials were immunized to enable them to be used for transporting oil of wintergreen and similar drugs. The method itself consists of hydrolising the immediate surface of the cellulose ester moulding back to the cellulose stage. This will then provide a naturally solvent resistant film on the surface of the moulding. A number of hydrolising agents were tried, but eventually sodium hydroxide solution, containing a little ethyl alcohol as a softening or penetrating agent, was found to be the most successful. The physical properties of the moulding appeared to be unattacked by the treatment.

Although some changes in the appearance occur, usually in the form of a slight dulling of the surface, Tables 5 and 6 show the effect of short- and long-time immersion of treated and untreated samples of cellulose acetate plastics in a number of solvents. In both cases the surface hydrolysis was effected by immersing the sample for one minute in a 3 per cent. sodium hydroxide solution in a 75 to 25 water/ethanol mixture. It

Table 6.—Effect of Continuous Immersion of Surface-hydrolysed and Unhydrolysed Cellulose Acetate Plastics in Certain Solvents. (Based on cellulose acetate of 38 per cent. acetyl content.) (Gearhart[5].)

Solvent	Untreated (36 hours' immersion)	Surface hydrolysed one minute in 3% alcoholic potassium hydroxide (16 hours' immersion)	Surface hydrolysed one minute in 3% sodium hydroxide in 75–25 water-ethanol (36 hours' immersion)
Ethanol	Swelled	Swelled	Swelled, blushed
Ethanol 75%, water 25%	Swelled badly	—	Some swelling
Ethanol 50%, water 50%	Some swelling	—	Some swelling
Ethanol 25%, water 75%	Slight swelling	—	Slow swelling
Isopropanol 50%			
Water 50%	Swelled badly	—	Swelled badly
Methanol	Swelled badly	—	Swelled badly
Butyl acetate	Non-solvent	—	—
Methyl cellosolve acetate	Dissolved	Dissolved	Swelled badly, skin wrinkled
Carbitol acetate	Dissolved	Partly dissolved	Some swelling
Ethyl lactate	Dissolved	Dissolved	Swelled badly, skin wrinkled
Triacetin	Surface swelled and dissolving	Unaffected	Unaffected
Methyl phthalate	Surface swelled and dissolving	Unaffected*	Unaffected*
Methyl cellosolve	Dissolved	—	Surface partly dissolved
Cellosolve	Dissolved	Partly dissolved, swelled badly	Swelled badly
Carbitol	Swelled	Swelled	Swelled badly
Ethylene dichloride	Swelled badly	Swelled badly, distorted	Swelled badly
Methyl ethyl ketone	Dissolved	Dissolved	Very badly swelled
Oil of lavender	Unaffected	—	Unaffected
Oil of pennyroyal	Surface softened	—	Unaffected
Oil of lemon	Unaffected	—	Unaffected
Oil of eucalyptus	Unaffected	—	Unaffected
Oil of wintergreen	Slight swelling	—	Unaffected

* Immersed for 310 hours without affecting sample.

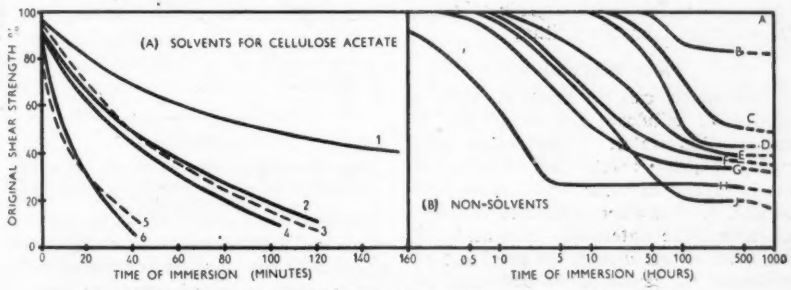


Fig. 6.—Effect of solvents on cellulose acetate sheet. (Delmonte[4].)

Table 7.—Permeability of Cellulose Acetate to Water Vapour. (Deeg and Frosch[7].)

	Thickness	Diffusion constant
Cellulose acetate A–17 (unplasticized), moulded	0.0979	114.0
Cellulose acetate A–17 (unplasticized), acetone cast	0.0402	287.0
	0.0450	310.0
Cellulose acetate, commercial sheet	0.0030	36.1
	0.0136	34.2
	0.0542	38.4
Cellulose triacetate, (unplasticized), moulded	0.1027	71.2

Solvents—
1. Ethylene dichloride.
2. Ethyl acetate.
3. M.E.K.
4. Chloroform.
5. Methyl acetate.
6. Acetone.

Non-solvents—
A. Carbon tetrachloride (no effect).
B. Butyl alcohol.
C. Toluene.
D. Benzene.
E. Amyl acetate.
F. Butyl acetate.
G. Ethyl alcohol.
H. Methyl alcohol.
J. Cellulose.

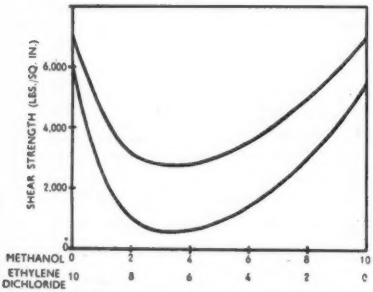


Fig. 7.—Effect of solvent combination on cellulose acetate sheet. (Delmonte[4].)

can be seen that the effectiveness of the treatment is mainly confined to short-time contact with solvents although it is helpful in reducing the effect of long-time contact in the case of a number of plasticizers and oils. It would seem that solvent immunization is a useful treatment to be given to acetate mouldings of any kind, which are likely to come into occasional contact with organic solvents, for example, laboratory fittings.

Water Absorption

Two effects can be observed when a sample of cellulose acetate plastic is immersed in water. The plastic progressively absorbs water to a more or less steady maximum value, and a small proportion of plasticizer is leached out and passes into the water. The magnitude of these two effects is regarded as giving an important indication of the behaviour of the plastic in service, as they are accompanied by small dimensional changes and, of course, the electrical characteristics change with increase in moisture content. Considerable variation of mechanical properties also takes place with variable moisture content, and these will be discussed in a later section of this series.

Table 8.—Effect of Plasticizers on Water Permeability. (Deeg and Frosch[7].)

	$D \times 10^{-6}$
Ethyl cellulose :	
Unplasticized	77.0
5% dibutyl phthalate	68.0
25% dibutyl phthalate	73.0
45% dibutyl phthalate	118.0
5% Dow No. 6	73.0
25% Dow No. 6	33.0
45% Dow No. 6	22.0
Polyvinyl 95-chloride 5-acetate :	
Unplasticized	0.7
30% tricresyl phosphate	2.7
30% Santicizer M17	4.4
30% dioctyl phthalate	4.7
30% Flexol 3GH	36.5

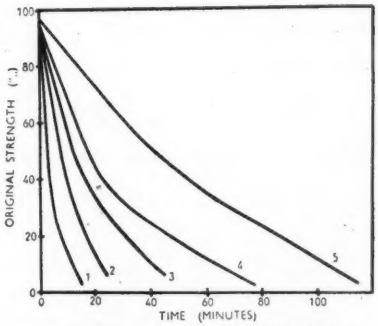


Fig. 8.—Effect of thickness of cellulose acetate sheet on rate of attack by acetone. (Delmonte[4].)

1. 0.03 in.
2. 0.047 in.
3. 0.066 in.
4. 0.085 in.
5. 0.120 in.

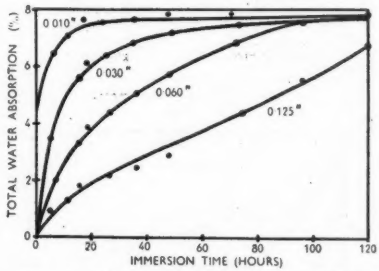


Fig. 9.—Water absorption of cellulose acetate sheet at 25 degrees C. (Lawton and Nason[8].)

Results of water-absorption tests are usually expressed as the percentage of water taken up by the plastic, following 24 hours immersion in water at 77 degrees F., corrected for any soluble material removed by the water. This latter figure is recorded separately, and is determined by reconditioning and reweighing the sample. To avoid the double action of the water it is tending to become the practice in Britain simply

Table 9.—Influence of Fillers on Permeability. (Deeg and Frosch[7].)

Composition (by weight)				
Ethyl cellulose (150 cps.)	55.0	30.6	55.0	30.6
Dibutyl phthalate	45.0	25.0	—	—
Dow No. 6	—	—	45.0	25.0
Whiting	—	44.4	—	44.4
Diffusion constant $D \times 10^{-9}$	118.0	73.0	22.0	16.0

Table 10.—Permeability* of Cellulose Acetate Sheet to Gases. (Davis[8].)

Thickness of sheet	Temperature	Relative humidity	Carbon dioxide	Oxygen	Nitrogen
0.0009	21°C.	0%	10,000	970	160
0.0009	21°C.	75%	8,600	510	120

* Number of micrograms (10^{-6}g.) of gas passing in 24 hours through a film 1 sq. m. in area and 1 mm. thick, when the pressure differential is 1 cm. of mercury.

to expose the weighted samples to a 95-per-cent. r.h. atmosphere for several days and then to re-weigh; the soluble matter is estimated separately as above!

Some figures for water absorption and soluble extract, plotted against time of immersion, are given in Figs. 9 and 10. Upper values for modern cellulose acetate compositions usually run rather lower, being of the order of 2-4 per cent. water absorption and 1-5 per cent. solubles lost.

Permeability

The permeability of cellulose acetate film and sheeting, particularly to water vapour, is especially important when considering its use for any packaging or wrapping purpose. The fact that acetate sheet is completely permeable to water vapour is often overlooked by those who use it. A recent example is the use of a completely sealed cellulose acetate container for an aqueous toilet preparation. The freshly filled pack looked perfect and was completely free from leaks, but within a few weeks so much evaporation had occurred through the acetate film that the walls of the cylindrical container collapsed until they nearly met. Weight measurements taken showed that this sealed half-pint container was losing water at the rate of nearly 8 grams per day!

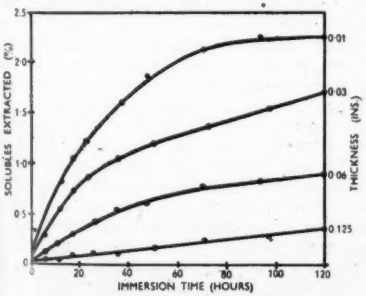


Fig. 10.—Extraction of solubles from cellulose acetate sheet by water immersion at 25 degrees C. (Lawton and Nason[6].)

The actual value of the permeability is determined by using a small cell containing a desiccant and with a sealed lid of the cellulose acetate or other plastic film. The cell is weighed and then exposed to an atmosphere of known temperature and humidity, and the increase of weight with time is recorded. The value is expressed as the permeability constant D, which indicates the number of grams of water diffusing through a centimetre cube of plastic in one hour under a vapour pressure difference of 1 mm. mercury. Other standard conditions or dimensions are also sometimes specified. Some values, taken from a paper by Deeg and Frosch are given in Table 7.

As would be expected, the triacetate

(Continued on page 495.)

Films and Bubbles from Molten Plastics

IT may seem a far cry from soap bubbles to plastics, yet many of the experiments which one carried out in the home or the laboratory during our schooldays, using a few pieces of bent wire or a clay pipe and some soap solution, may equally well be performed using molten polythene. Although this equipment may seem rather crude, the results which can be obtained with it are not without technical significance, since it only requires some further mechanical adaptation to produce quite useful products.

Most people to-day are familiar with the clear transparent astrodomes in our modern aircraft. These have been made by blowing (or sucking under vacuum) flat sheets of "Perspex" after the latter had been softened by heat in an oven. A less familiar article, in this country at any rate, is the plastic bottle, which is made by blowing a bubble of molten polythene, or polystyrene, inside a cold mould, which serves to chill and set the polymer in the required form.

In another example of this technique, the blown bubble is drawn out continuously in a tubular form from a suitable supply nozzle; in size, the result may range from a small capillary tube to a large tube 2 ft. or 3 ft. in diameter. Some of these tubes may have their ends sealed off to form bags, for the packaging of all sorts of edible things from milk to turkeys! Alternatively, the larger tubes may be slit along their length to form continuous lengths of flat film.

A new idea capable of further development is the use of thin films of molten polythene to form a seal on various articles, which may range from oranges, or small metal parts, to containers, such as bottles, jars and the like. These melt films shrink quite considerably within a few seconds on cooling to form tough, protective skins or covers, which remain completely unaffected by moisture or by chemicals, such as strong acids, alkalies, etc.

Due to the high temperature (about 150 degrees C.) at which these films are first formed, they are quite sterile and free from fingerprints or other sources of contamination, which could set up mould growth in the case of food packagings, or cause corrosion of metal articles.

This sealing process makes use of the soap-film idea in that a wire ring or hoop is dipped into a bath of molten polythene and is then removed, together with the thin film of polymer which is formed thereon by surface tension. The article to be covered may be dropped on to the surface of the film and allowed to pass through the ring as the film is stretched all round it. Alternatively, the film on the ring may be placed over and around the neck of the bottle or other container which it is desired to cover, and the article or container then rotated to remove the film from the ring.

In some cases two rings may be used to encompass the article with a film from each side, and the films then heat-sealed together and any excess removed, if desired, by cutting with a very hot knife.

Stabilization of P.V.C.

The degradation and stabilization of polyvinyl chloride has been discussed by V. W. Fox, J. G. Hendricks, and H. J. Ratti, of the National Lead Co., Brooklyn, N.Y., in a paper before the American Chemical Society at their recent Chicago meeting. Referring to the deleterious action of heat and light in promoting changes in the colour and physical characteristics of unstabilized p.v.c., it was pointed out that these changes are sufficient to prohibit the use of p.v.c. in many otherwise desirable applications. The following suggestions were put forward for an ideal stabilizing system: (1) Agents capable of removing the hydrochloric acid formed, as insoluble products; (2) reactive molecules capable of breaking up colour-producing polyene systems; (3) selective ultra violet absorbers capable of reducing the total ultra violet energy of incident light; (4) selective agents capable of inhibiting reactions initiated by the passage of unscreened ultra violet light energy.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Balance Pans

Sir,—As manufacturers of pharmaceutical scales and balances, we use considerable quantities of glass scale pans, which are in the shape of a shallow, concave dish approximately 3 ins. in diameter. Two major disadvantages of glass are the breakage factor and the difficulty of obtaining a standardized weight, without excessive cost, by grading and rubbing down, whilst the big advantage is the resistance of glass to any usual form of corrosion.

We are wondering if there is available any synthetic material capable of reasonably cheap manufacture into such pans, which would also prove extremely resistant to corrosion or attack in any form from the various chemicals normally in use in a chemist's dispensary, and which it would be reasonably simple to reduce to a standard weight.

W. A. WEBB, LTD.

4-5, Skinner Street, London, E.C.1.

"Saran" Trade-mark

Sir,—There has come to hand the March, 1948, issue of "Plastics," on page 136 of which appears a notice to the effect that the Dow Chemical Co., Midland, Michigan, has formally released its trade-mark rights to the name "Saran," thus permitting it to become the descriptive name of the product.

This notice contains a true statement of the facts in so far as they apply to the United States. However, our company has never entertained the thought of vacating its trade-mark rights to "Saran" in other countries. We authorized sending of the notice in question only to U.S. publishers. We are therefore taking this opportunity to explain to you the true state of affairs.

THE DOW CHEMICAL CO.

Midland,
Michigan, U.S.A.

Kallodent Moulding Machine

Sir,—Might I make an appeal through your columns to anyone possessing a Kallodent moulding machine, which they would be willing to sell, to contact me. Although this model is generally regarded as obsolete it would be adequate for work in connection with facial prostheses, for which it is required by the hospital.

GORDON HUNNINGS,
Prosthetic Technician.

Christie Hospital and Holt
Radium Institute,

Wilmslow Road, Withington,
Manchester.

[EDITOR'S NOTE: This type of machine was employed for moulding acrylic resins especially prepared for the manufacture of dentures.]

Nest Eggs

Sir,—Will you kindly let us know the names and addresses of the actual manufacturers of white plastic poultry nest eggs. GEORGE H. ELT, LTD.

Eltex Works,
Worcester.

[EDITOR'S NOTE: We believe that moulding of plastic "eggs" for the specific purpose of deceiving hens into performing the useful function of sitting on them is being carried out by Healey Mouldings, Ltd., of M.A.P. Factory Estate, West Bromwich Rd., Walsall. On the other hand, plastic "eggs" made from urea resins for use as perfume containers, and as Easter "eggs" to contain chocolates, were produced long before the war and it seems surprising that the nesting "egg" to replace the china type is relatively new. The container type were obviously made in two halves and hollow and may have been too light in consequence. Solid "eggs" could readily be made, or alternatively, cellulose acetate or other thermoplastics could be injection moulded in two halves and cemented together. Since hens are sometimes cannibalistic, mouldings of considerable strength are required.]

Measurement of Tear Resistance

THE accepted method of determining the tear resistance of rubber sheeting is to subject a sample of standard size and shape, the edge of which has previously been nicked, to a tensile tester with a standard rate of separation of the jaws. Under these conditions the usefulness of the result, of course, will depend upon the care with which samples are prepared, particularly the accuracy with which the nick is measured.

A cutter designed by Imperial Chemical Industries, Ltd., to overcome the difficulty of cutting accurately a nick of 0.02 in. in samples of rubber sheeting, was described in an article in the "India Rubber Journal" (June 22, 1947), by J. M. Buist and R. L. Kennedy, on "Tear Resistance." This instrument is now produced commercially by Avimo, Ltd., of Taunton, Somerset. It is designed with particular regard to the difficulties experienced in testing sheeting of soft, unloaded rubber compound and gum stocks. An accuracy test carried out on 72 test pieces of 2 mm. rubber sheets gave a standard deviation of 0.0013 in. in the depth of the nick; this represents a tolerance value plus or minus three-thousandths of an inch.

The instrument has a heavy base, cast in one piece, with machined guide rails, along which the sample carriage travels. The rubber sample is clamped in the carriage by means of two spring-loaded discs. A razor blade is held firmly in a clamp, and when the sample carriage is moved along the rails, the edge of the blade enters a narrow slot in the carriage and cuts the rubber. The carriage is rebated to hold the test piece accurately, and is relieved in the neighbourhood of the slot, so that the rubber here is gripped firmly.

The height of the clamp which holds the razor blade is controlled by an adjustable screw stop, the movement of which is measured by a dial micrometer reading in 1,000th inch.

The test piece is placed in the carriage, and the lever is depressed to allow the carriage to travel over the blade, which should first be brushed with soap solution. After being moved back and forth six times between the stops, the carriage is withdrawn and sample removed.

The nick is measured by means of a microscope, and the error taken up on the micrometer. Thus if the nick is found to be 0.025 in., the razor-blade clamp stop is lowered by 0.005 in., measured on the micrometer dial, and the test is repeated with a fresh sample. Use of the instrument will enable routine tests to be carried out with accuracy and without loss of time. The resulting tear-resistance figures are claimed to have a high standard of reliability. Bench space occupied is only 8½ ins. by 5 ins.

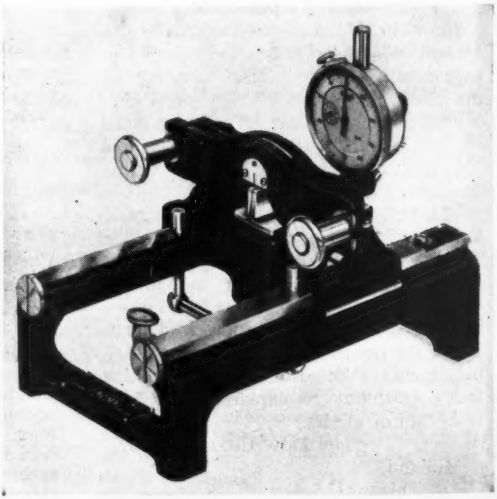


Fig. 1.—This new pump of patented design is provided with an impeller made of neoprene.

Pump Impeller for Severe Service

NEOPRENE has been used to solve a rather unusual problem in the patented design of a pump illustrated in a recent issue of "Neoprene Note Book," which deals with work of the Rubber Chemicals Division of E. I. Du Pont de Nemours and Co.

As seen from Fig. 1, this pump consists essentially of a metal housing, a drive shaft, and an impeller made of a special neoprene compound. The action of the impeller is shown diagrammatically in Fig. 2. When the pump is in operation, the flexible impeller blades rotate against a cam or offset plate located within the housing just above the intake and outlet ports. As the blades reach this offset plate they are distorted from their normal position, but on leaving the offset section the impeller blades snap back, and the resulting partial vacuum draws in liquid through the intake ports. As the impeller continues to rotate, liquid is carried through the pump and is discharged through the outlet port.

Obviously, the efficiency of this pump depends principally on the impeller. The blades must withstand constant and severe flexing, and in order to function must retain their resilience. Neoprene was, therefore, chosen as the material of construction because of its resilience, low permanent distortion and resistance to flex cracking. Abrasive action also had to be considered. Here, again, neoprene was suggested because abrasive effect of sand, silt and other particles on the housing is minimized by the resilient blades. As a further need, the blades must resist the cutting and chipping effect of these abrasives, and again neoprene was indi-

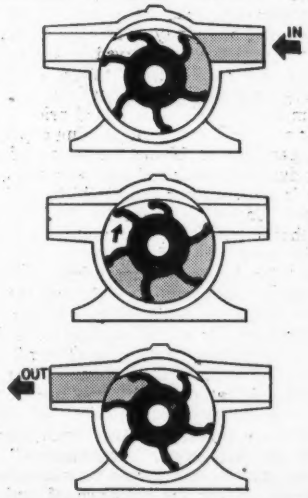


Fig. 2.—Diagram of pump in operation, showing constant flexing action of the neoprene impeller.

cated because of its resilience and excellent resistance to abrasion.

Since the pumps in question were designed for use in chemical, industrial, dairy, bottling and food plants, as well as for marine and farm applications, neoprene was desirable because it could be compounded for chemical inertness as well as for its resilient properties and wear resistance.

In commenting on the service life of the neoprene impeller, the manufacturer states that " under satisfactory conditions the life of the neoprene impeller is amazingly long. Pumps have been known to operate several years with their original impellers, which sometimes last as long as the metal bodies themselves." Solid and abrasive materials in suspension were handled efficiently without clogging.

The advantages claimed for this pump are its simplicity, efficiency and adaptability. There are no gears. There is no metal-to-metal contact in the pumping chamber, and no lubrication is required for the impeller, since it is lubricated by the liquid being pumped.

Advice to Authors of Papers for Plastics Institute "Transactions"

THE " Transactions " published by technical societies and institutions serve a particularly useful purpose in distributing new and often highly specialized knowledge among those who are in a position to make use of it in industry. Without such publications technical progress would be considerably slower, and much might never receive the publicity it may deserve. Those who expend part of their valuable time working on a paper to be read before some particular professional body may fully realize this, yet they are sometimes dismayed in the experience of considerable delay before that paper actually appears in print, unless it is by custom that preprints are issued prior to the meeting. The shortage of printing paper has been partially to blame for some of this delay during the war and post-war years, but there is also another cause which needs be stressed. Indeed, it is not too much to suggest that too few authors realize the need for the manuscript of a paper to be " prepared " for the printer, apart from giving it an accepted consistent style throughout and so presenting the subject-matter in the best possible form for ease of reading and subsequently consulting in the printed word. All of this, of course, takes time—hence the delay in publication which sometimes occurs.

With due concern for this state of affairs, and a desire to expedite the appearance of papers in their own " Transactions," the Plastics Institute has caused certain rules to be drawn up for the guidance of authors. With that meagre experience in editorial procedure concerning which we refrain from boasting, we may say that we heartily endorse what has been set forth in these rules, and it is with the object of assisting the work of the Plastics Institute in the task of publishing its " Transactions " that here and now we give the main points of these rules, and commend them to authors whose papers are intended for publication.

Manuscripts should be typewritten in double spacing, upon one side only of each sheet of paper. Flimsy paper, or any which is particularly absorbent to ink, should be avoided.

Authors should endeavour to become familiar with the recognized nomenclature of plastics. So far as possible, references to existing literature should be verified, and recognized abbreviations used for the titles of publications. References should include year of publication, volume, and page, further identification (i.e., month or number of part) being added where pagination is not continuous throughout the volume.

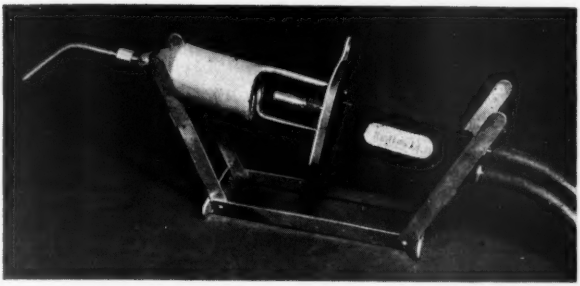
Line illustrations should be drawn in Indian ink on smooth, white paper, and at least twice the size they are to appear when printed; smooth graph paper with faint blue lines may be used as alternative. Lettering must be proportionately large to allow for photographic reduction. (If expert lettering is not possible, it should be added in blue pencil to enable the process artist to deal with it.)

Photographs intended for use as illustrations should be in the form of glossy black-and-white prints.

All illustrations should have appropriate captions, and tables of data should have short explanatory titles.

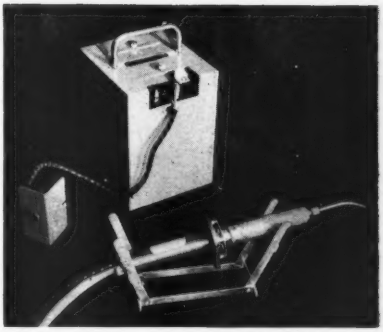
PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



Gas torch (left) and electric torch and transformer (below), as used for the flame welding of thermoplastics.

WELDING TORCHES.—We have on several occasions already referred to the flame welding of thermoplastics by means of a gas-heated or an electrically-heated torch. Our illustrations on this page show two of the torches which are supplied by Rediweld, Ltd., of Bromhill Road, Wandsworth, London, S.W.18. The gas-welding torch weighs only 14 oz. and is suitable for the welding of either polythene or p.v.c. The heating gas employed is acetylene, and the welding gas is nitrogen or compressed air. The electrically-heated torch weighs 15 oz., and operates from a step-down transformer 200/240/42 volts. It is equally suitable for the welding of either polythene or p.v.c., and has advantage over the gas torch in that an additional gas cylinder is not required. In use it is only necessary to connect to a supply of the welding gas. Spare parts for the gas torch, e.g., stainless steel coils, nozzles, injectors, etc., can be supplied; likewise spare heating elements.



BRITISH EXHIBITION IN COPENHAGEN.—The British Exhibition to be held in Copenhagen from September 18 to October 3 will be the largest and most comprehensive display of British goods ever held in Denmark or in Scandinavia. The exhibition is organized by the British Import Union of Copenhagen in co-operation with the Federation of British Industries. The last British Exhibition in Copenhagen was held in 1932.

EXPORT LICENSING.—As from September 13, 1948, the headquarters of the Export Licensing Branch of the Board of Trade, now at Stafford House, King William Street, E.C.4, will be removed to Regis House, King William Street, London, E.C.4. Telephone: Avenue 3111.

INDUSTRIAL ART.—Members of the F.B.I. Industrial Art Committee have this year awarded their annual prize of £80 to Mr. William Stanier, a student specializing in glass design at the Royal College of Art. The award is given to the student of the College whose industrial design work is thought the most promising. Mr. Stanier is a former student of the Stourbridge School of Art and was awarded a Royal Scholarship on the entrance examination to the Royal College of Art in 1939.

T. H. and J. DANIELS, LTD., Lightpill Iron Works, Stroud, Glos, makers of plastics moulding plant, are holding an "open day" on Saturday, October 23, when they will be inviting their customers to visit them, and inspect their works and the

machinery which they make. A similar "open day" was held recently for employees, their wives, families and friends.

NATIONAL PLASTICS, LTD.—Particulars have been registered of an increase in the capital of National Plastics, Ltd., by £500,000 in 10s. ordinary shares, beyond the previous figure of £1,500,000.

R. H. COLE AND CO., LTD., inform us that Mr. N. Cannon, jnr., export manager to the Dow Chemical Company of Canada, has recently been on a visit to England in connection with the Canadian company's new export expansion policy. Products of the Dow organization at present include polystyrene moulding granules under the trade name of "Styron."

AMERICAN CYANAMID CO. have recently formed a plastics and resin division. Mr. James L. Rodgers, Junr., formerly general manager of the Plaskon Division, Libbey-Owens-Ford Glass Co., with experience in plastics dating back to the original production of urea resins, has been chosen as general manager of the new division.

A. C. WICKMAN, LTD., have produced a film describing the technique of using Wimet tungsten carbide cutting tools. The film was shown at the Machine Tool and Engineering Exhibition recently held in London.

"DURESTOS" TRADE MARK.—We have been asked by Turner Brothers Asbestos Co., Ltd., of Rochdale, to remind our readers that "Durestos" is a registered trade mark belonging to that company.

E. SHIPTON AND CO., LTD.—Mr. M. Freund, Dipl. Ing., M.I.Mech.E., is now employed by this company in the capacity of technical consultant.

GEORGE COHEN, SONS AND CO., LTD., machinery merchants, Wood Lane, London, W.12, have published a fully illustrated 128-page brochure about the activities of their group of companies. It has been prepared especially for export distribution, and in condensed form is to be published also in French and Spanish.

BAKELITE LTD.—It is announced that Mr. H. V. Potter, B.Sc., F.R.I.C., M.I.Chem.E., has been elected chairman of the board of directors of Bakelite Ltd. in succession to Sir James Swinburne, Bart., F.R.S., who has decided that the time has now been reached when primary control of the affairs of the company should pass into the hands of a younger man. Sir James, however, will still remain a director of the company. Mr. Potter, who has been managing director of Bakelite Ltd. for 20 years, will continue in that position, combining these responsibilities with those of chairman.

It is more than 30 years since Mr. Potter first joined the Damard Lacquer Co., Ltd., the predecessor of Bakelite, Ltd. He started as a research chemist, and in a few years became manager, later a director, and subsequently the chief executive officer of the company.

SIR FREDERICK BAIN, president, F.B.I., and deputy chairman, I.C.I., Ltd., has been nominated a member of the Anglo-American Council on Productivity. He will represent the chemical industry.

MR. J. B. FORTUNE, M.Sc., M.I.Mech.E., works manager of Hornflowa, Ltd., has been made a Liveryman of the Worshipful Company of Horners, following on his admission to the Freedom of the City of London.

PLASTIC INSTITUTE NOTES

Luncheon.—The Plastics Institute is holding a luncheon at the Dorchester Hotel, Park Lane, London, W.1, on Friday, October 8, 1948, at which the President, Mr. H. W. Graesser-Thomas, will give an address.

Annual General Meeting.—Our reference last month to elections to the committee should have read "Mr. P. R. S. Gibson" and not "Mr. A. J. Gibson."

NOTES FROM BRITISH PLASTICS FEDERATION

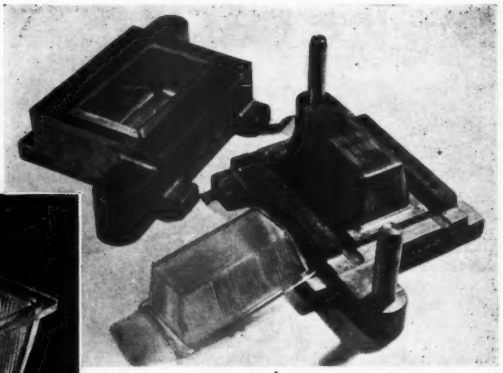
Visitor from the United States

The members of the Council of the Federation had the pleasure of meeting Mr. George Clark, president of the Society of the Plastic Industry, New York, and of entertaining him at lunch at the Savoy Hotel on July 26. It was Mr. Clark's first visit to this country. He has very kindly answered a number of questions from Federation members regarding the S.P.I.

German Micro-films

The Federation is co-operating with the Technical Information and Documents Unit of the German Division of the Board of Trade in the abstracting of information from micro-films relating to the German plastics industry.

New Productions from the Moulding Shops



Mine Lighting

The development of coal-face lighting led to need for transparent enclosures capable of offering good resistance against breakage by impact, and otherwise satisfying the requirements of British Standard 889. Simultaneously with the suggestion to employ a plastic material for the transparent part of flameproof fittings in mine lighting, however, came the thought that careful consideration might have to be given to the question of surface softness in the plastic, and possible dust collection caused by reduced static charges. Nevertheless, it seemed that acrylic mouldings might satisfactorily meet all requirements, and various experimental fitments were put into production. Quite recently further experiments have been made in the pressing of refractor dishes for tungsten lighting units applied to mines. The bulkhead lighting cover illustrated, in "Perspex," proved successful as a moulding, although care has to be taken in use, otherwise "demoulding" of the prisms is likely to occur. One of our illustrations also shows the "open flash" type mould, with knife-edge cut off, which is employed in making these covers. (Photos by courtesy of I.C.I. Plastics Division.)

Polythene Beakers

The beaker illustrated has been put into production by Tamworth Plastics, Ltd., of Alders, Tamworth, Staffs. It is of polythene, and therefore unbreakable and non-staining; equally important, it can be sterilized in boiling water without losing shape or character. The "dignified" clear lines are pleasing and are greatly enhanced by the long, conventional handle. The thickness of the cup wall is ample, so that the whole is sufficiently stiff and therefore avoids any inconvenience to the user which might otherwise be caused by the semi-flexible nature of the polythene.

"Perspex" in Aircraft

In the new Percival Prince, latest Percival aircraft, more use has been made of "Perspex" acrylic sheet than in any aircraft hitherto constructed. Apart from transparent "Perspex" for canopy and windows, the Percival Prince contains over 50 items made from "Perspex" coloured sheet, transparent or opaque. The entire wash-basin unit—basin, soap and towel trays and the facing—weighs only 5¾ lb. and the first-aid box less than 2¼ lb.

Quality Control in Plastic Moulding—X

By W. M. HALLIDAY

Continuing the study of fraction-defective forms of quality control, which are based upon customary checking by "go" and "not-go" gauges to specific limits, we now turn attention to the use, applications, and various advantages to be gained from the introduction of the combined or two-way control chart.

Sometimes it is essential that plastic mouldings be produced without any defectives, or with an exceedingly small percentage of defectives. To facilitate the inspection control necessary to meet such stringent requirements, special control charts known as the "compressed-limit" type have to be applied.

The construction, application, and several practical advantages associated with the use of such modified special fraction-defective charts are illustrated and described in this present article.

IN the preceding instalment in this series it was shown how very advantageously fraction-defective control charts and methods may be adapted in order to effect control of the productions from multiple-cavity moulds. Alternatively, the methods and types of sub-charting were explained for dealing with the inspection of components having a number of different dimensions, or other features which have to be maintained within specified limits of variation.

To achieve the above objects, it will be recalled, a number of inter-related sub-charts were recommended, these being employed in close conjunction with the main control chart. Each sub-chart may be used either to record variations occurring in respect of a particular feature on each moulded article; or to be applied one each for every cavity impression contained in the moulding tool.

By their use it becomes readily possible for the inspector to check a progressive production run produced from multiple impression tools, or to control a variety of different dimensions and features on each component with complete assurance that an adequate degree of gauging, checking, and recording of resultant data is furnished for the better guidance of the inspector, mould operator, and setter.

Two other very important aspects of the application of fraction-defective control methods still remain to be discussed in this present section before completing the interesting study of this subject.

In both compression and injection forms of moulding operations, instances arise from time to time where it proves insufficient for an inspector merely to know the *overall* variations taking place in respect of the products, which information is afforded by the kind of control charts so far considered and illustrated.

When the method of gauging of the moulded component is by "go" and "not-go" type gauges against specified high and low limits of variation, it is often advisable and sometimes vitally necessary for the inspector to be able to determine from a glance at the charts whether the components are being rendered defective by reason of their exceeding the high limit, or falling short of the low limit, or from both reasons.

Information of this more precise nature will prove particularly helpful if the moulded product possesses some important dimension, say, upon which variations have to be very closely watched in order to keep the part within the permissible limits laid down by the client, or designer.

The charts and sub-charts illustrated and fully described in the preceding article are undoubtedly extremely useful for applying to the general run of plastic moulding production. Readers will, however, appreciate that the information given by them at any point during a run

relates only to the overall errors or defectives occurring. What they fail to reveal readily is the *scale* of errors taking place, or whether defectives are arising from the failure to meet the high, or low limits, or both. For this lack the inspector is unable to determine with precision just in what manner the parts are defective.

At first glance this may seem a somewhat unimportant point, but the citing of an actual example will help to indicate the value of such information both to the inspector, mould operator, and mould setter. The moulding selected comprised a thin-walled cup-like article, involving deep coring in the mould in order to produce the internal shape of the part. It was produced from a four-cavity injection mould with a production cycle time of one shot every 70 secs. This was the floor to floor time. Strict limits of variation were specified in respect of the diameter of a certain portion of the internal form of the moulding.

During a production run of 10 days it was found that the total number of defectives produced equalled 3 per cent. of the whole output. This figure incidentally was considered quite normal to this particular moulding operation, for in fact a permissible defective percentage of 4½ per cent. had been allotted. A 100 per cent. examination of these defectives, rendered necessary for an entirely different reason, revealed the surprising information that no less than 82 per cent of the defective components were so by reason of their being above the permissible high limit on the hole diameter.

Translating the above percentages into actual quantities, out of a total of 16,000 components produced in the period, 480 were defective, and no less than 393 out of the latter quantity were defective because of being in excess of the high limit.

This very illuminating information prompted an immediate and thorough examination of the mould and the moulding procedure generally, in an endeavour to locate the reasons for such a consistent variation in this single direction, which obviously was quite distinct from the usual chance causes of variations. As a result it was found that the normal time in each cycle of movements allowed between the injection shot entering the mould cavity and the final ejecting of the finished parts, was greatly in excess of that originally specified for the operation of the mould. This delay in parting the mould blocks after each shot was found to be due to a very minor mechanical defect which had developed in regard to the ejector system, this necessitating a longer dwell before the operator was able to part the blocks and complete the ejection of the four moulded components.

Since the cores required for forming the internal opening in the moulding were carried on the movable mould block, the result of the prolonged dwell meant that the mouldings were actually being retained on their cores for a much longer period than necessary. As a result the parts were unable to shrink normally, a major portion of the contraction upon cooling having to be gained at the expense of a slight stretching of the thin walls, which, incidentally, proved under a subsequent test to have resulted in a slight weakening of the walls at a certain point.

Correction of the mechanical defect connected with the ejector mechanism eliminated the need for this additional delay in ejecting the finished parts, enabling the four mouldings to be ejected from their cores within the specified time, so as to allow them to shrink freely down to the proper hole diameter when the room temperature was reached. This was a very simple cause, and its elimination at once secured a reduction in the total defects registered previously by about 1½ per cent., or in actual component figures a saving of 190 parts over the period being considered.

It may be urged that such a mechanical defect on the mould should have been observed by the operator or setter. Probably that might have occurred had the operator been highly observant and conscientious throughout the entire

working day. On the other hand, in response to some judicious questioning he did admit to noticing the slight fault, but since he found that he could operate the mould quite well by making a slightly longer dwell he thought the matter too trivial to report. As most production engineers will be aware this kind of thing frequently happens, and the most trifling defect occurring in a mould may produce awkward or very undesirable defects on the moulded part.

The main point in connection with this incident, which the author desires to stress, however, is that this small and apparently unimportant defect in the mound ejector mechanism might easily have passed unnoticed by the inspector for a considerable time, simply because the ordinary type fraction-defective charts would not have revealed the trouble.

As already mentioned the total defective rate was well within the limits laid down at the commencement of the job, and to all intents the production was under adequate control. The point escaping notice was that quite an appreciable proportion of the defective components could have been avoided.

By using control charts of the modified kind which will be fully described and illustrated later in this present article, the tendency and exact degree of the errors occurring in the mouldings can be graphically presented for the better guidance of the inspector and the mould setter.

Another important consideration arising out of the actual instance just quoted above, is that the total permissible defective rate allocated to this particular production was fixed at 4½ per cent. The nature of the defect to the mould ejecting gear was such that it would very slowly have deteriorated. So much so that if attention had not been devoted to its correction the scale of the defects in the finished mouldings would have gradually worsened.

With the ordinary fraction-defective chart no action would have been deemed necessary until the proportion of defectives had risen to 4½ per cent. Such an increase from 3 per cent. to 4½ per cent. might easily have taken place over a period of production of say one month, from which it will be clear that a very large quantity of avoidable defectives would have been turned out, and charged against the moulding shop either as scrap or for the additional costs involved in their correction.

From our consideration of this actual moulding experience readers will doubtless also appreciate the several other valuable ways in which adapted control charts of the "two-way" kind will be able to assist the inspector and mould setter.

Thus by sharply and promptly indicating as production proceeds whether the finished components are being rendered defective because of failing the high, or low, or both limits, many of the very minor operating snags and mould faults will be brought to the notice of the inspector, and via him to the attention of the mould setter, much sooner than would be otherwise reported. Successful plastics moulding largely consists of detecting and correcting those numerous mould defects at a sufficiently early stage.

Furthermore, valuable savings will be made in the number of parts actually rejected as defective, which when spread over a substantial production run will prove quite considerable and ample to repay the little extra time and trouble required to institute such charting arrangements.

Yet another useful purpose fulfilled by such information is to reveal pictorially at a very early stage during the life of a new moulding tool, whether it is likely to prove satisfactory during production, or whether it is likely to cause trouble because of its inability to produce components below the high limit, or above the low limit, or because of its incapacity to meet both limiting requirements with consistent accuracy and reliability.

Information of this kind, if ascertained and made available to the component inspector at the outset when a new mould

is first placed into production service, will often enable the production engineer and mould designer to get together. As an outcome of such joint consultation in endeavours to adapt the mould to the client's requirements, they may decide upon either a different method of working the mould; or the introduction of some modification to its mechanism; or the elimination of small errors of workmanship, and so forth, to permit it to produce moulded articles within the specified limits.

It will also permit the production engineer to decide at a sufficiently early stage whether the limits applying to the components are in reality too stringent, the attainment of which is likely to incur a good deal of worry and trouble to those concerned. Possessing such knowledge, the production engineer will then become forewarned and in a position to impress upon those directly concerned with the working of the mould, and the associated inspection of the finished parts, of the need for additional caution and care in respect of certain activities.

Usually this information will also render possible considerable economies in the extent of inspection attention to be afforded the product. For example, the "two-way" type of control chart may indicate that the bulk of the defectives are so because a particular dimension or feature continually falls short of the low limit say, but is well within the high limit, or vice versa.

With many plastics mouldings it may then become possible to arrange for the gauging and plotting of the components by the low limit gauge with much greater frequency than with the high limit gauge. Since separate charts are employed for each limit on the job a greater degree of gauging of one limit can easily be plotted to present a graphic picture of the variations taking place.

Information of this character, whilst seemingly unimportant when regarded separately in each single instance just given, may assume entirely different proportions when these are taken collectively and their influence permitted to accumulate over a sufficiently lengthy production run. Their collective effects may then in practice make all the difference between a high or low rate of defective work; or the more economical operation of the mould; and the more early discovery of mould faults and errors before these have reached the scale of seriousness to cause an excessive number of defects or errors on the finished mouldings.

Construction and Use of Two-way Control Charts

With most forms of plastics-moulding operations it will be found that there are associated a number of variable and indeterminate factors, which are exceedingly difficult to anticipate and control. These factors will arise from time to time during an apparently normal production run as a result of the temperature instability of the mould or the plastic material employed. Lack of uniformity in the flow capacity of the moulding powder, due to extraneous influences, will also give rise to obscure and puzzling variations at the finishing end of the operation. Maladjustment of the water-cooling provisions in the mould, or the unequalized expansion and contraction of parts of the mould itself, are also other somewhat unpredictable factors. Another well-known generic factor often giving rise to a whole crop of minor variations in the finished product are the idiosyncrasies of the mould operator or setter.

The prevalence and effects of all these factors will have come to the notice of most production engineers at one time or another, and are sufficiently well known as to render it unnecessary to give a detailed description of them in this article.

These and other similar factors, if allowed to obtrude in plastics moulding, will result in certain quantities of defective components being produced at each production run, regardless of the accuracy of the moulding tool or the degree of precision with which the necessary sequence of the moulding operations are conducted.

Of course, if the mould is carefully and regularly checked and adjusted when

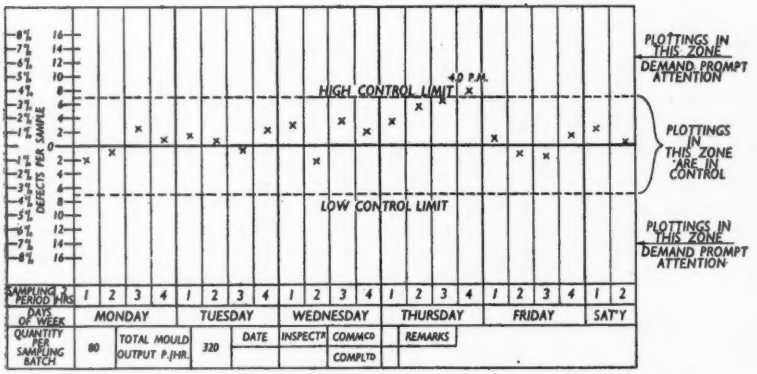


Fig. 1.—Typical two-way fraction-defective control chart arranged with equalized control zones.

necessary in order to retain its initial accuracy and smooth working condition, coupled with consistently intelligent usage, much may be accomplished in neutralizing the effects of such variable factors, and even in largely circumventing their occurrence. As a consequence, the resultant errors and defects in the finished components may be kept at a very low and economical figure.

Notwithstanding all this, however, it will be found even under the best operating conditions that defectives will be made. Some of these will occur by the failure of the parts to meet the low limit, and some by failing at the high limit set for the job.

With the mould properly adjusted, and maintained throughout a production run to produce moulded articles generally to the mean value of the high and low limits permissible for the components, one would expect that approximately half of the quantity of defectives would lie on or outside the high limit, and the other half on or below the low limit. This feature is utilized by quality control engineers to form the basis of what is known as the "two-way" control chart (Fig. 1).

Referring to this illustration, which, by the way, is a typical two-way chart arranged for application to plastic moulding processes, readers will observe that essentially it consists of two charts identical in form arranged around a central mean datum. The lower horizontal ordinate, which is made common to both charts, is suitably graduated into the days of the working week, these in turn being subdivided into a number of equal spacings each representing the allotted period at which samples are taken from production for gauging. The left-hand vertical ordinate is divided up into a number of equal spacings to denote the numbers of components checked and the percentage correct and those defective.

The lower chart is employed for recording the number of components failing the low limit; the upper chart for those failing the high limit. It will be observed that the lower chart is an exact replica of the upper, except that it is inverted. In this present example the central datum line indicated by the zero mark is the exact mean between the two values high and low limit.

Each chart is provided with a control limit datum shown in heavy broken line, this being determined in the following simple manner: First of all, the production data required for the determination of the control limits should be ascertained in the manner described in Section VIII of this series ("Plastics," July, 1948, pages 374-5), this being the normal

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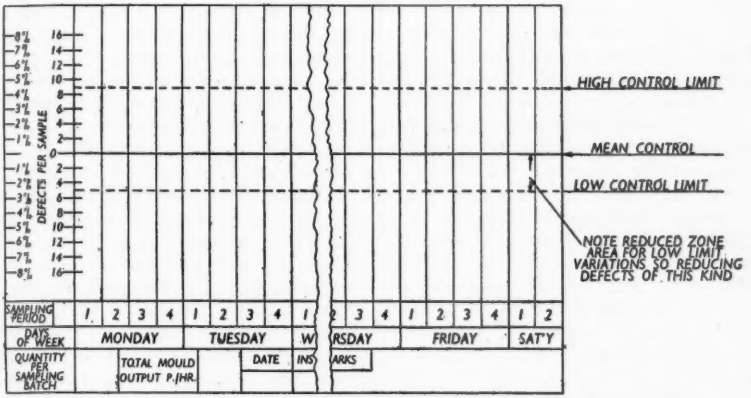

Fig. 2.—An adjusted form of two-way control chart having restricted control zone on low limit.

procedure for ordinary fraction defective charts. From this information the control limits are calculated along the same lines as given on page 377.

This control limit, giving the graph positions for the upper and lower limits, should be *halved* when being applied to the "two-way" control chart now under consideration. Each half of that limit is then set on each chart, or, in other words, disposing the control limits equally about the central datum zero, as shown.

Should the total control limit result in an odd or fractional number, one limit established on the "two-way" chart will have to be greater than the other. Whether to dispose this on the high or low limit chart will usually be easily determined from the results obtained from a brief production run. Thus, should it be found that the tendency of the mould is to produce components with the majority of the defectives occurring on the high limit side, whilst the low limit is easily maintained, then the greater control limit value could be situated on the high limit side. This important point will be dealt with in closer detail later in this article, as a result of which readers will realize the value and facility afforded by this provision.

The left-hand vertical ordinate of both charts is graduated in a twofold manner as shown, so as to denote not only the actual number of defectives, etc., but also the percentage of defectives. This will be found very convenient in that it conforms to the same procedure adopted with the ordinary form of fraction-defective control charts previously described in this series.

Use of Two-way Control Chart

All the other relevant information appertaining to the production operation and inspection requirements, as well as job identification, should be included in suitable compartments on the two-way chart exactly in the same manner as on the normal chart.

For the better guidance of readers, this specimen chart is illustrated complete with a complement of plotted points as obtained from a production run over a full working week. As will be noted, the great majority of these plottings are located closely around the central datum, thus indicating that the production is proceeding normally under ample control. On the Thursday, however, it will be seen that the plotted points on the upper high limit chart are approaching the control limit. No action need be taken by the inspector, however, until the plottings

pass above the control limits as indicated at the fourth inspection check on this day.

At this point it was found that 8 components, out of the sample batch being gauged, were in excess of the high limit of the "go" and "not-go" gauge, meaning that a quantity of defectives had already been produced. The size of sample batch was 80 components. The percentage average of 8 parts out of 80 being a fairly high proportion, indicates to the inspector encountering such an occurrence that an investigation was required. Action need only be taken by the inspector, therefore, if and when plotted points occur in the outer zones on the charts. Whilst plottings fall within the heavy broken lines of the two control limits he is assured that the defective percentage is being maintained within the requisite levels.

Thus the interpretation of the "two-way" control chart is almost identical with that of the normal fraction-defective chart, but possesses the added advantage of immediately directing the inspector's attention to the *precise manner* and *extent in which the production is passing, or has passed out of control.*

If, after a reasonably long production run, it is found that the fraction defective of the products are failing because of their exceeding either the high or low control limits, it is possible for the inspector to institute a still closer and more reliable check on the output so as to reduce the incidence and quantity of such defectives.

This may readily be accomplished by readjusting the zone between the two control limits each side of the central datum zero. By setting over any desired proportion of the control zone into one or other of the charts, a restriction in the area over which plotted points may occur is then secured. In actual charting of a production progress such a readjustment of the control zones would mean that a still closer check can be kept on variations liable to take place in the direction shown previously to involve the greatest tendency towards error.

In this connection it is worth while digressing here to point out that instances of plastics moulding designs and shapes sometimes are encountered where it is found that a defective component can be easily rectified, if the error is associated with one limit in preference to the other one. For example, in the case of precision mouldings required for mechanical or electrical purposes, if holes and recesses into which other members are to be fitted are moulded to the low limit or below it, ways and means are available for enlarging the holes, etc., after the parts have left the mould. On the other hand, should such portions be moulded large and to the high limit, little can subsequently be done to reduce them to the correct size.

Likewise, with male spigots and registering shoulders upon which other components have to be located and positioned. If these should be made to the low limit or under, it will prove extremely difficult to salvage the part, whereas if the spigot, etc., were to be made to the high limit or slightly over, usually a secondary shaving operation can be arranged in order to reduce the dimension to the correct size.

Incidentally, with such precision mouldings this aspect deserves to be closely borne in view by the designer and inspector when laying down the working tolerances for these particular dimensions, and especial care requires to be devoted to the question of tolerances for any gauges needed to check such dimensions on the finished mouldings. Very often it will be found that the client's tolerances on the projected component allow some latitude above the customary moulding shop working tolerances. Whatever excess there may be in the former tolerances should be utilized to give the most latitude on the dimensions which can be most easily rectified.

Therefore, with moulded parts of the above nature, to ensure a more reliable and rigorous check upon their production it may prove advisable to adjust the two-way chart in the manner just

described so that greater latitude is afforded one or other of the limits. By this means any defectives occurring in the product would be represented by plotted points in the increased zone of control, indicating they were those most easy to correct in cases where the outer control limit of such a zone were to be exceeded. Similarly the proportionately reduced control zone on the other chart for the opposed limit would indicate with greater precision if and when the production was passing out of control in this direction.

In order to illustrate how such a simple adjustment is effected a specimen chart is depicted at Fig. 2, this, in effect, being an adjusted form of the chart already given at Fig. 1.

In certain extreme cases, where strict adherence to one limit on the job has to be closely maintained, the production engineer might find it advisable to locate almost the whole of the control zone on either the high or low limit chart as the case may be. With a chart of this kind covering a production where defectives on one limit could not be permitted, any plotted point occurring outside the zone in the other chart would immediately indicate the need for stopping production.

Advantages Derived from the Two-way Control Chart

Earlier in this article mention has already been made of some of the many useful purposes to be fulfilled by the "two-way" control chart of the kind just illustrated. Other important advantages worthy of being noted at this point are here very briefly suggested for the consideration of readers.

The first advantage to be noted is the greatly additional guidance afforded the inspector and mould setter, and one should include the mould operator. When the two latter persons become fully conversant with the use and interpretation of such charts considerable assistance will be given then in the determination of the extent of a defect shown in the product, what is more important, guidance for them in diagnosing its causes.

In addition, indications of a developing fault or error in the product will be shown with greater exactitude and also much earlier than is the case with the normal type of chart. As already intimated, in actual moulding practice the speed with which a defect is revealed is often of paramount importance.

The second advantage relates to the greater flexibility possessed by the two-way chart. Such flexibility in the adjustment and location of the control limit datums and zones to suit circumstances will often afford the greatest facility and benefit to the inspector, both in meeting special tolerance requirements, and in maintaining the total quantity of defective components to a minimum figure.

A third advantage is that better control is exercised over all those chance variations liable to occur in plastics moulding operations, variations which are generally unpredictable and arising from no previously known cause.

When variations from chance causes are noted much assistance may be gained if the actual time of the occurrence is inserted into the control chart in the manner shown at Fig. 1. Likewise, if an operator should be changed or some modification executed on the mould, or if slightly different moulding material is employed, all such important information should be plainly indicated on the chart.

Restricted Limit Control Charts

A still further very important adaptation may be made to the fraction-defective control chart to overcome one serious limitation connected with their use. This drawback is that ordinary defective charts, illustrated and described earlier in this series, are not suitable in cases where production has to take place without any defectives, or at the worst a very small percentage.

Normally such charts only afford warning to the inspector when defectives have actually been produced, and moreover such a warning is only given when two or more defectives appear in each

sampling batch. When two or more such defectives occur in a sample batch, it has to be remembered that the actual quantity of defectives produced in the period from which the sample was taken will be considerably greater because generally the sampling batch is only 25 per cent. to 30 per cent. total production during that period. Therefore, to assess the total quantity of defects in the total products made one must multiply the charted defect quantities by the proportion of the size of sample batch to the total output in any given period.

For these reasons, therefore, the fraction-defective chart is of little assistance in cases where it is desirable to prevent the manufacture of defects. Even when a small percentage of defects can be permitted in a production the ordinary type fraction-defective chart may prove of little use because in order to be certain that say only one defective piece shall occur in any given single sample batch, the sample batch size and its ratio to the total production may have to be so great as to constitute in effect practically 100 per cent. checking and gauging of the components.

Fortunately, as already intimated, another method of chart construction and usage is available, whereby these foregoing drawbacks can be satisfactorily overcome, in the manner now to be described.

By employing what is known as the "restricted or compressed limit" control chart, it is possible to secure a reliable and accurate running commentary upon any given moulding operation, which will be based upon a very small number of defectives per sample batch, viz., one or two components only, and at the same time to maintain the size of sampling batch within economically small proportions to the total output.

Gauging equipment of the "go" and "not-go" type can be used in conjunction with such restricted-limit charts, but with this difference in comparison with gauging for ordinary control charts. Specially stringent tolerances have to be provided, these being much smaller than the limits specified on the blueprint of the moulded component. The purpose behind the use of such finer gauges being to obtain special manufacturing tolerances so as to produce artificial defectives. These artificial defects are then represented on the control chart in the usual manner to provide the running commentary upon production.

On the restricted limit control chart the relationship of the control limit datums is modified in order to coincide with the closer manufacturing limits decided upon. Thus, with a restricted control chart constructed on the same scale as an ordinary fraction-defective chart, the control zone would be much smaller. For this reason it will be advisable to make the restricted-limit chart to a much larger scale, so as to ensure greater ease in compiling it during a production run.

With such a chart, should it arise during the progress of a production process that plotted points, representing variations in the accuracy of the components occur outside the confines of the compressed control zone, the inspector will at once know that rejects are being produced, which might prove defective to the larger limits required by the customer.

Ordinarily, such components will not be scrapped in respect of the specification tolerances, but are only to be regarded as defective to the special closer limits established for the manufacturing purposes. Such "moulding shop defectives" would then be isolated and set aside pending a 100 per cent check on every dimension or feature, and, if required, eventual correction to conform to the client's specification.

It may now be asked: On what basis are such finer limits for sampling gauges, and the control zones on the restricted-limit chart, to be determined?

Much depends, of course, upon the degree of precision required on the work, but, generally speaking, with plastics mouldings where tolerances of plus or minus 0.001 in. are rarely demanded, the following will prove a safe rule:—

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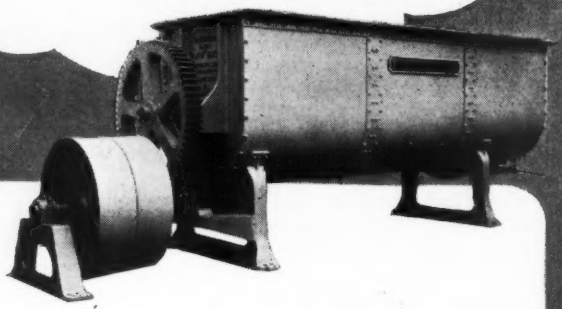

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In the case of the sampling gauges, these should be of the "go" and "not-go" type, but the tolerance between the high and low limits should be made from one-fifth to two-fifths of the customer's specification limits. The positions of the control limits on the chart should be ascertained in the manner previously described.

The sample batch size need not be large as in the case of ordinary fraction-defective charts. A quantity ranging from 10 per cent. to 20 per cent. of the total production from a mould during a given period will be found to produce very reliable results. The frequency of taking samples from a production run should be determined in the same manner as is required for the ordinary fraction-defective chart, with this single qualification: When using restricted-limit control charts it is rarely necessary to take more than 5 per cent. of the total production for sampling and gauging. Generally, a proportion as low as 3 per cent will be found to give excellent results.

When establishing control by restricted-limit charts, therefore, the production engineer will have to balance out the sample size and interval between taking samples, to obtain such a percentage, giving preference, of course, to the period for taking samples. In other words, it will usually prove more satisfactory to reduce the size of sampling batches and to take checks of samples with greater frequency.

For preference, the restricted-limit type control chart should be of the "two-way" kind, illustrated at Fig. 1, and fully described in the present article. This affords a closer check upon any variations occurring in respect of each limit. The chart itself is plotted in exactly the same manner as with the "two-way" chart. As soon as a plotted point occurs on the limiting datums bordering the control zone action should be taken at once.

In conclusion, it is worth while pointing out that the gauging equipment employed in conjunction with the restricted-limit charting methods must be afforded constant attention in the form of checking to master size blocks to ensure adherence to original accuracy. Such action is necessary, because the gauges will be subjected to more severe wear, and in view of their much finer tolerances between the "go" and "not-go" points, even a slight amount of wear may seriously affect the tolerance range.

(To be continued)

CELLULOSE ACETATE PLASTICS

(Continued from page 477.)

has a much lower value, due presumably to the smaller number of free hydroxyl groups present in the polymer. The difference in the value for commercial sheet and for unplasticized cast and moulded cellulose acetate shows the importance of plasticizers in reducing permeability. A further example of the effect of plasticizer content is shown in Table 8 for ethyl cellulose, figures for cellulose acetate not being available in the literature. Table 9, also for ethyl cellulose, indicates the effect of fillers. The permeability constant is also affected considerably by changes in temperature[10] and in relative humidity.[7]

In common with other plastic materials, cellulose acetate is also permeable to gases; the values for carbon dioxide, oxygen and nitrogen are given in Table 10.

(To be continued.)

REFERENCES

(1) *Delmonte,* "*Modern Plastics,*" 1942/*Dec.*/91. **(2)** *Delmonte, ibid,* 1941/*Sep.*/63. **(3)** *Kline, Rinker and Meindl, ibid,* 1941/*Dec.*/59. **(4)** *Delmonte, "Ind. Eng. Chem.,"* 1942/*June*/764. **(5)** *Gearheart,* "*Modern Plastics,*" 1944/*Sept.*/140. **(6)** *Lawton and Nason, ibid,* 1945/*June*/150. **(7)** *Dege and Frosch, ibid,* 1944/*Nov.*/155. **(8)** *Davis,* "*Modern Packaging,*" 1946/*May*/145. **(9)** *Kline, Martin and Crouse,* "*Modern Plastics,*" 1940/*Oct.*/119. **(10)** *Doty, Aiken and Mark,* "*Ind. Eng. Chem.,*" 1946/*Aug.*/788.

The Microscopic Examination of Plastic Materials

VII.—Mouldings (Contd.)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

CONTINUING our examination of the coconut-shell flour-filled moulding, we saw that the extra fluidity of the resin at the mould faces resulted in the formation of vortices due to the impacting of large filler particles at the surface. Before proceeding further, it should be pointed out that this is possible only by virtue of the very fluid nature of the material mass containing the resin and small filler particles. As already pointed out, these filler particles are hard and suffer little or no change in the processing; in these circumstances they may be expected to be more mobile, as all the operative forces act as causing movement of the particles, rather than being partially absorbed in morphological distortion, as occurs in the softer filling materials. As a result of this, evidence of the existence of turbulence in the structure is more marked in the case of the coconut-shell filler.

The logical outcome of examining sections of the surface of this material is to interpolate the conclusions arrived at in terms of their effect on the finish of the moulding. It is well known that the finish of any given moulding is dependent on the fineness of the filler and the development of a thin film of resin on the surface; therefore, let us look at the surface of the coconut-shell-filled material at somewhat closer quarters.

Fig. 322 shows a portion of the surface of this moulding, in section, at a magnification of 100 diameters. The first most outstanding characteristic seen is the remarkable freedom from irregularities in the surface, indicating a highly finished moulding, as, indeed, the specimen was. It should be pointed out here that production of very good finishes is a characteristic of the coconut-shell filler, and as the mould used for this moulding possesses an excellent finish, the fine edge (E) seen in the photograph is not unexpected.

It is quite clear that, in this case, the finish is dictated mainly by that of the mould; nevertheless, the structure immediately behind or under the surface is of interest, because a study of this reveals that the surface is not entirely dependent on the filler itself, but that the orientation of the particles at the surface exerts some influence. Thus, in the illustration under consideration there are seen to be two large particles, A and B, lying against the surface of the moulding. In considering the effects produced by their presence in this position, it will be noticed that there is a gap or pocket of clear resin separating the two particles and, at the same time, it becomes evident that the two particles concerned have

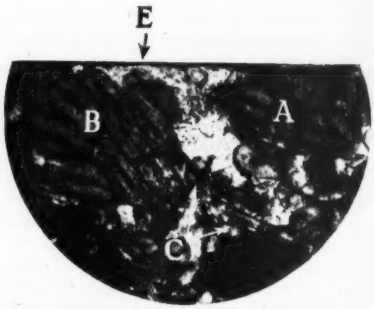

Fig. 322.—Transverse section of coconut-shell filled moulding, showing resin pocket at surface. Mag. 100 diameters.

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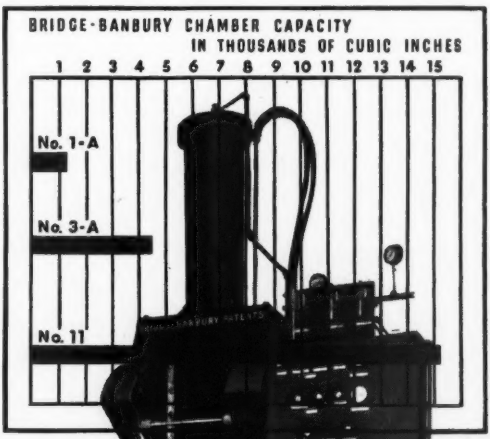

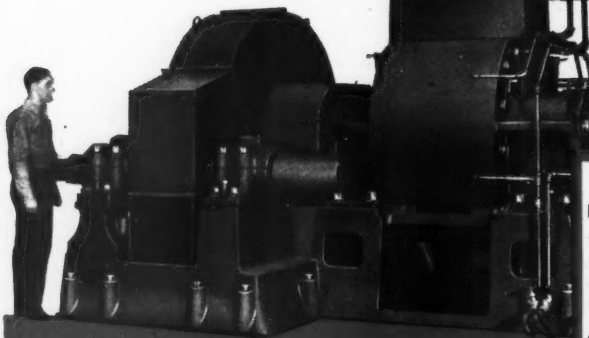

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been mainly responsible for the existence of this pocket, which appears to have been brought about by blocking due to the particles C wedging in the entry of the gap.

The whole structure of this pocket is somewhat curious, inasmuch as it is difficult to see exactly why it should exist, for if there was a sufficient difference in pressure to cause wedging of the small particles, then it might be expected that particles A and B would have been pushed aside to allow the small particles to enter and fill the gap. As against this, there exists a condition where the particles are obviously blocked and the gap becomes filled with resin. It is possible that herein lies the answer to the problem, for it must be remembered that the heat is being applied from the outside and, at the same time, the pressure is being exerted throughout the mass, but does not become truly evenly distributed until the whole mass is lignified. Thus, this formation might be produced as a result of the rapid lignification of a comparatively thin layer at the surface.

If this assumption is applied to the case under discussion, it will be seen that it could be possible for particles A and B to take up their places almost immediately, and before any lignification occurred. In this event, sideways movement would be prevented by surrounding particles, and those behind A and B would be wedged, thus leaving a void, which would only exist for a short time as lignification would undoubtedly have already commenced in the surface layer. However, as the filler particles are very hard and appear to be able to withstand considerable pressure without breaking up, the void would suffer little if any collapse, and liquid resin would flow into the cavity and fill it. This means, of course, that the resin has been virtually "strained" through the structure surrounding the void, under the influence of the external hydraulic pressure existing in it.

It will be seen that the void would be very quickly filled, and as the resin is in a very fluid condition the pressures both inside and outside the void would soon be equalized and the whole structure would tend to float slightly as the resin ran underneath it. This would account for the presence of a thin film of resin at those points where particles A and B might be expected to be in contact with the mould surface, as is seen to be the case in the illustration.

From this it will be clear that all over the mould surface a relatively thin layer of rapidly hardened material is built up. This layer would possess an uneven surface on the inside, and the next layer to form would be subject to the effects of this surface. Apart from this, the first formed layer would possess poor heat conductivity, in consequence of which the formation of subsequent layers would take progressively longer towards the centre of the moulding. Thus, it is really not surprising that the various flow effects produced internally are met with. More particularly is this true farther away from the mould surface, as the mass is fluid for an appreciably longer time in these circumstances.

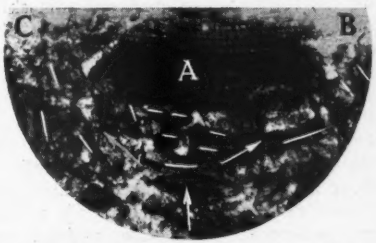


Fig. 323.—Coconut-shell filled moulding (transverse section) showing edge of surface. Mag. 100 diameters.

In spite of the rapid setting of the surface layer, we have seen that evidence exists showing that the mass is sufficiently fluid for a time long enough to allow the flow effects to come into operation. These are also to be seen very close to the surface, in addition to which variations of surface structure, due to the presence of particles of different shapes and sizes, are to be expected and, indeed, are encountered.

Continuing the examination of the surface of this specimen in some detail, Fig. 323 shows a portion of the surface in transverse section at 100 diameters, and also illustrates the effect produced by a single large particle when it appears at the surface. It will be noticed that the major effect of this particle (A) is to give rise to a pocket of clear resin at each end of the particle at B and C. It can be assumed with reasonable certainty that these pockets are the result of a blocking action, brought about by the position and size of particle A, which would cause the mass of resin and small particles behind it to be forced to each side in the manner indicated by the arrows. That this is so is in some degree supported by the orientation of the small particles where long axes are indicated by the short lines. Thus, it will be seen that the small particles tend to pile up at each end of the long one, and again act as a filler for the liquid resin which would flow into the spaces formed, and fill them. At the same time, this would flow under particle A and the two liquid masses would meet on the surface, producing one thin skin of resin seen to be covering the particle in question.

Having examined the effects of the particle, it is of interest to speculate on the possible effects which might result from this structure as a whole. It is clear that, as a result of the condensation, there is a decrease in the volume of the resin, and that the filler plays a useful part in absorbing the stresses arising from this shrinkage. However, when pockets of resin exist, it is equally clear that there is no filler in them to perform this function, and therefore an optimum size of pocket sets a limit to the point at which the self-crazing of the resin pocket will commence. This latter, of course, is due to the shrinkage just mentioned and also to that resulting from the cooling of the moulding. The optimum size of resin pocket has not yet been established, but there seems to be no reason to doubt that this is very much smaller than might be expected. For example, the pocket marked C in reality is very small, but it will be seen to exhibit some signs of crazing at the point D, where the surface can be seen to be breaking up.

From this it would appear that large particles of this nature are an undesirable feature in any filler, as it might be possible that surface crazing may result. It should, however, be remembered that when talking of these particles as being large, their size is really relative to the size of the average particle in the flour; thus, in the case under discussion, particle A is quite large when compared to those surrounding it, and it is possible that this relative difference in size might account for anomalies in surface finishes which are not normally expected.

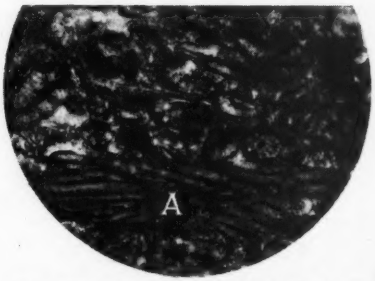


Fig. 324.—Coconut-shell filled moulding (transverse section) showing surface. Mag. 100 diameters.

Some measure of support for the orientation is obtained when we examine a portion of the surface where no such large particle is present. Looking at Fig. 324, photographed at 100 diameters, it will be seen that no large particle is present near the surface, although one marked A is situated some distance away. Between this particle and the surface of the moulding, however, there exists a closely packed mass of small particles.

It is clear from this that although particle A is present, but placed at some distance from the surface, it has not exerted a great deal of influence upon the flow of the mass containing the smaller particles. These will be seen to have packed themselves against the surface in

an orderly manner, exhibiting a very decided tendency to longitudinal orientation parallel to the mould surface. The net result of this unrestricted flow is to produce a surface which is remarkably smooth and even at the relatively high magnification used.

Some idea of the finish on this particular surface is obtained when it is realized that, at this magnification, a rise or depression in the surface of only one thousandth of an inch would result in a variation of 1/10 in. on the photograph. Such variations as are apparent are of really microscopic dimensions, and it will be appreciated that the surface is very smooth indeed. Nevertheless, it should be stated that the moulding powder in this instance was given every chance to produce its best results by the use of a mirror-finished mould, and it is evident that the material has justified its reputation for producing a good finish.

In discussing this structure, however, it should be borne in mind it has been assumed that particle A was present in

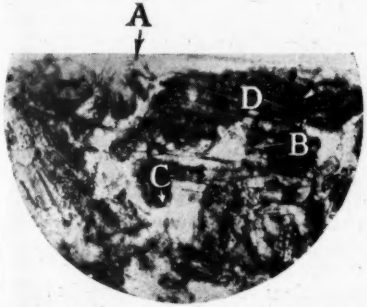


Fig. 325.—Coconut-shell filled moulding showing irregularity at surface. Mag. 100 diameters.

the initial stages. This structure might have developed equally well without the presence of this particle, which could have taken up its position after the solidification of the surface layer.

Although the portion of the surface already examined showed itself to be remarkably even and smooth, this does not occur all over the specimen; there must inevitably be some slight defects of the surface. Such a point is shown in Fig. 325, where, at 100 diameters, it will be noticed that the surface shows the presence of a decided hump. The significance will be appreciated when it is realized that, in actual fact, the total rise of the surface at the peak of the hump is approximately 1/1,000 in., and that this represents a slight unevenness in the polishing operation, which in itself is insignificant but serves to illustrate graphically the fidelity with which the mould surface is reproduced.

Apart from surface irregularity, there is a certain amount of interest in the structure of the surface layer of the moulding at this point, for it will be noticed that a considerable portion of the structure is composed of char resin; for example, the hump itself is largely made up of this material and pockets of appreciable size occur throughout the deeper structure of the layer, such as those at points B and C. The structure at this point in general does not exhibit the same degree of regularity encountered elsewhere in this moulding. Further, whereas a large particle D is present at the surface, this does not appear to have had any pronounced effect on the structural development of the surrounding mass, which shows very little sign of regular orientation such as seen hitherto.

The reason for this digression is not exactly clear, but it is suggested that it might be the result of localized turbulence, possibly arising out of some configuration of particles situated deeper in the moulding, which developed somewhat later than usual and was fixed by the solidification of the resin before sufficient time had elapsed for a regular structure to develop. However, it should be remembered that in discussing the regularity or otherwise of these structures the term is used in a comparative sense only, and that these structures cannot be compared in any way with the regular structures encountered in a material such as wood. The regularity of structure seen in these mouldings

should rather be regarded as being vestigial in nature, and occurring in a material in which no structure was originally expected. Such regularity as does exist serves a useful purpose from the diagnostic point of view, in that information regarding the behaviour of the moulding powder is obtainable.

Continuing our examination of the surface of this section, further study shows that surface pockets of appreciable size are also formed by the presence of large particles of filler which are not necessarily at the surface of the moulding. One such example is seen in Fig. 326, where the pocket has been due to the presence of the two large particles, A and B, causing a piling-up of the filler particles in the mass outlined at C, thus

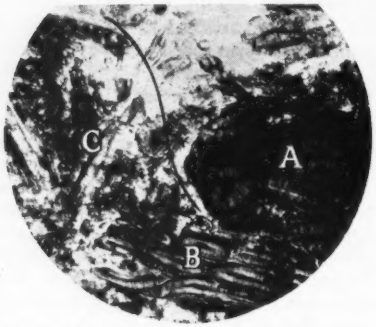


Fig. 326.—Coconut-shell filled moulding (transverse section) showing pockets. Mag. 100 diameters.

forming a void which quickly becomes filled with resin only and so results in a clear-resin mass.

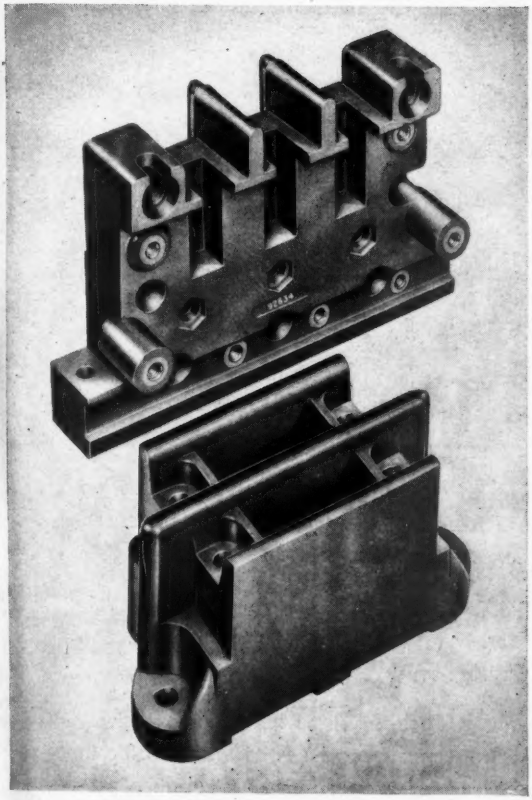
The significant feature of this illustration is that the two large particles are seen to be at some distance from the surface, so much so that there has been sufficient time for the mass of smaller particles to move under the large ones from the other end of these latter, which is not seen. This statement is in the realms of conjecture, for the converse might easily apply. The mass containing the small particles could have existed in the first instance as a layer against the mould surface, against which particles A and B were squeezed. It will be appreciated how this might result in the small particles being pushed out from beneath the larger ones; if this process became arrested by the setting of the resin before it was complete, some such structure as that shown may be expected to be produced. But whether the configuration arises as a result of either of the afore-

Fig. 327.—Coconut-shell filled moulding (transverse section) showing close packing at surface. Mag. 100 diameters.

mentioned series of events, or whether the basic cause originates from some other set of circumstances not yet taken into account, the fundamental conditions resulting in the structure are not truly known. The existence of this and other structures noted, however, is indisputable.

It is probable that one of the reasons underlying the development of such configurations in the coconut-shell filled moulding is the absence of any observable effects on the filler particles, due to the high mechanical forces encountered by these during the moulding cycle. This has been one of the outstanding structural differences met with when comparing this material with those previously examined, wherein it was seen that mechanical distortion of the filler particles was the rule rather than the exception.

It might be argued, however, that as the structures in the coconut-shell filled moulding so far examined have consisted



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mainly of those portions showing the existence of relatively low concentrations of filler particles, these latter could be expected to show little sign of the physical effects of pressure, as they would be more or less suspended in a fluid medium.

It can be demonstrated that even where very close packing of the filler particles occurs, no signs of mechanical damage are evident. Thus, it is reasonable to suppose that any tendency to distortion would be more noticeable where high filler concentrations occur at the mould surface. Such a point is illustrated in Fig. 327. Here, the actual sharp edge representing the surface of the moulding is not clearly defined, due to halation effects; however, it is plain to see that the particle concentration is high and that they are very closely packed to produce a dense mass showing no clear-resin products.

Embedded in this mass may be seen two large particles, A and B, in which we are fortunate to find A in longitudinal section and B in transverse section. From a study of these particles it becomes evident that in neither case is there any sign of the coconut-shell elements exhibiting physical distortion, such as crushing. Indeed, the bores of those elements seen in transverse section are shown to be unaffected and the minute structure of the cells themselves is visible, in so far as the magnification will allow. Thus there appear distinct signs of the familiar pit channels, and the general structure of the coconut shell appears unaltered.

This portion of the surface shows no pocket formation and the whole structure is homogeneous to a high degree, despite the presence of the two large particles. From this it is clear that resin pockets are not necessarily a result of the mere presence of particles such as these, but are more likely to arise from conditions developing during the stage in the moulding cycle when the material is plastic, and therefore no hard-and-fast rule can be laid down as to their origin. However, it may be stated that, where the large particles occur near the surface, in the

Fig. 328.—Section of coconut-shell filled moulding showing long particle. Mag. 200 diameters.

majority of cases the development of resin pockets may be expected, for a structure such as that illustrated in Fig. 327 does not occur very frequently; indeed, it is comparatively unknown. This must not be confused with the more generally existing structures, containing no resin pockets at the surface.

In the absence of evidence to the contrary, it may be assumed that the formation of these pockets is due to comparatively large variations in size of the filler particles; in other words, to a high variability index for this latter material. Further, it would also appear that there is a greater tendency for these structures to develop with hard fillers, such as coconut-shell flour, whose particles can withstand the mechanical forces experienced in the moulding cycle.

We have so far examined only the grosser details of the structure of the coconut-shell filled moulding. Proceeding to the examination of the finer details, one of the first points for consideration is the detailed structure of the shell particles themselves. It has just been pointed out that at the relatively low magnification of 100 diameters there were visible some of the finer details of the particles, but they were not as clear

(Continued on page 506.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 599,935. Application date: 3.9.45. Convention date (Switzerland): 2.9.44. Accepted: 24.3.48.

To: Patelhold, Patentverwertungs & Electroholding A.G.

R.F. heating of articles of irregular shape. In order to achieve uniform field distribution and uniform heating, the articles are immersed in a liquid (oil) with a dielectric constant equal to or greater than that of the body to be heated.

B.P. 600,065. Application date: 6.10.44. Accepted: 31.3.48.

Production of Chemically Resistant Pipes and Tubes. G. C. Tyce. To: Imperial Chemical Industries, Ltd.

Chemically resistant pipes made by winding flexible fibrous sheets (asbestos) coated on one side with polythene by means of a flame spray-gun over a mandrel and heating the assembled pipe to effect fusion of the polythene, simultaneously exerting pressure.

B.P. 600,145. Application date: 28.9.45. Convention date (U.S.A.): 29.9.44. Accepted: 1.4.48.

Improvements in or relating to the Treatment of Copolymers. To: Imperial Chemical Industries, Ltd:

Thermal cracking of tetrafluoroethylene, ethylene or isobutylene copolymers to obtain oils and greases.

B.P. 600,146. Application date: 28.9.45. Convention date (U.S.A.): 29.9.44. Accepted: 1.4.48.

Improvements in and relating to Condensation Products of Thiourea. To: E. I. Du Pont De Nemours and Co.

B.P. 600,155. Application date: 28.9.45. Accepted: 1.4.48.

A Method for Coating Surfaces. C. F. Lumb. To: Schori Metallising Process, Ltd.

Spraying of plaster, cement or plastic materials through a spraying gun using superheated steam.

B.P. 600,164. Application date: 28.9.45. Convention date (U.S.A.): 7.10.44. Accepted: 1.4.48.

Improvements in or relating to Moisture-proof Coated Sheets or Films. To: British Cellophane, Ltd.

Moisture-proof sheet or film consisting of an organic non-fibrous base (regenerated cellulose, gelatin, casein or a polyvinyl resin) and a moisture-proof coating comprising a film-forming agent, a wax moisture-proofing agent and a slip agent (ethylene–1,3 dioxolane copolymer). The film can be heat-sealed.

B.P. 600,198. Application date: 19.10.44. Accepted: 2.4.48.

Improvements relating to the Bonding of Surfaces together with the Use of Synthetic Resin Glues. W. Ohr. To: Unity Heating, Ltd.

Bonding of surfaces by means of synthetic resin glues which are poor conductors for current. The resin film heats up when current is passed through, and bonding is effected under pressure.

B.P. 600,249. Application date: 23.6.44. Convention date (U.S.A.): 23.6.43. Accepted: 5.4.48.

Improvements in and relating to the formation of Solutions of Polymeric Materials. To: E. I. Du Pont De Nemours and Co.

Preparation of solutions of acrylonitrile polymers which are clear and colourless.

B.P. 600,270. Application date: 3.4.45. Accepted: 5.4.48.

Improvements in the Manufacture of Dolls, Animals and like Toy Figures and Parts thereof. H. Senior. To: Cascelloid, Ltd.

Casting of dolls, etc., by pouring a p.v.c. dispersion into a heated split mould, draining off the excess of the dispersion and final heat curing.

B.P. 600,296. Application date: 22.10.45. Convention date (U.S.A.): 21.10.44. Accepted: 5.4.48.

Improvements in or relating to the Preparation of Fluorohydrocarbons. To: Imperial Chemical Industries, Ltd.

Refers especially to vinyl fluorides.

B.P. 600,304. Application date: 25.10.43. Convention date (U.S.A.): 22.9.42. Accepted: 6.4.48.

Improvements in or relating to Protective Clothing and Flotation Suits. C. W. Leguillon and C. P. Krupp. To: B. F. Goodrich Co.

B.P. 600,317. Application date: 14.11.44. Accepted: 6.4.48.

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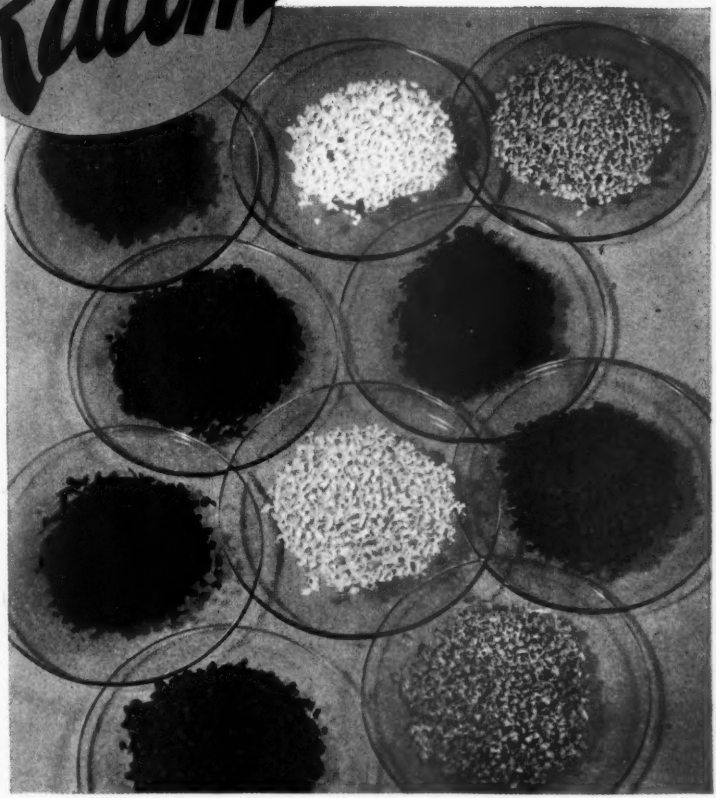

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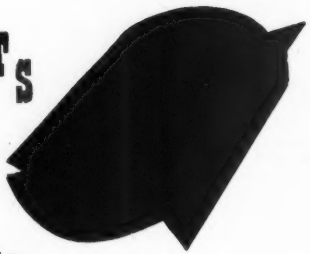

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T.P.14A

Improved Process for the Low-temperature Polymerization of Olefinic Materials. To: Standard Oil Development Co.

B.P. 600,369. Application date: 21.9.45. Accepted: 7.4.48.

Modifying Leather by Treatment with Novel Sulphonated Polymeric Materials. M. T. Goebel and J. S. Kirk. To: E. I. Du Pont De Nemours and Co.

Modifying leather by subjecting it before, during and after tanning to contact with a solution of a sulphonated polymeric material (derived from a copolymer of styrene with maleic acid). It is claimed that the tanned skins so obtained are rounder, fuller and lighter in colour.

B.P. 600,407. Application date: 14.11.44. Accepted: 8.4.48.

Improvements in the Production of Adhesives. R. M. Kerry and A. E. T. Lawrence. To: International Bitumen Emulsions, Ltd.

Bonding of laminates using an emulsion which becomes dilatant by loss of water, containing not less than 50 per cent. of bituminous material and not more than 50 per cent. of water, sodium metasilicate, an emulsifying agent (casein or soap) and rubber or artificial resins.

B.P. 600,408. Application date: 16.11.44, 12.7.45. Accepted: 4.4.48.

Improvements in or relating to the Manufacture of Synthetic Resinous Condensation Products. E. A. Bevan and R.S. Robinson. To: Beck, Koller and Co. (England), Ltd.

B.P. 600,473. Application date: 6.2.45. Convention date (U.S.A.): 2.9.44. Accepted: 9.4.48.

Improvements in and relating to Film of Resins or other Plastic Materials. To: Wingfoot Corporation.

Self-supporting plastic film having one smooth and light reflecting surface and another surface of suede appearance, produced by casting a solution of a copolymer of vinyl chloride-acetate on to a surface coated with polyvinyl alcohol having small surface irregularities, evaporating the solvent from the cast film and removing the film from the casting surface.

B.P. 600,569. Application date: 10.1.45. Convention date (U.S.A.): 30.3.44. Accepted: 13.4.48.

Cation Exchange Resins and Production thereof. J. R. Dudley. To: American Cyanamid Co.

Water-insoluble cation exchange resins made by reacting sulphuryl chloride or phosphorus oxychloride with furfural or a mixture of aldehydes containing more than 50 per cent. of furfural in the presence of an anhydrous solvent, gelling the mixture, hydrolizing the gel and subsequent insolubilisation of the gel by heating.

B.P. 600,575. Application date: 11.4.45. Convention date (U.S.A.): 11.4.44. Accepted: 13.4.48.

Method of Preparing and Treating Plastic Fabrications. R. Anderson.

Method of fabrication for a rigid supporting article (surgical cast) by fabricating an article from a soluble plastic material in thread form, subjecting the article to a treating solution which has a low solvent action on the plastic at 70 degrees F., thus allowing forming of the article to the desired shape and subsequent removal of the liquid to effect setting in the desired shape.

B.P. 600,618. Application date: 31.1.45, 12.7.45. Accepted: 14.4.48.

Improvements in or relating to the Manufacture of Synthetic Resinous Condensation Products. E. A. Bevan and R. S. Robinson. To: Beck, Koller and Co. (England), Ltd.

Manufacture of modified alkyd resins by reacting an alpha-beta unsaturated aldehyde, which does not contain conjugated ethylenic unsaturation and which is not readily polymerized with an alpha-beta unsaturated dicarboxylic acid, ester, etc. (maleic acid), and reacting the product so obtained with a fatty oil, fatty acids and, if necessary, with an alcohol to complete esterification.

B.P. 600,628. Application date: 23.4.45. Accepted: 14.4.48.

Improvements in or relating to the Manufacture of Composite Fibrous Sheet Material. H. Kremer.

B.P. 600,662. Application date: 29.9.44. Accepted: 15.4.48.

Improvements in or relating to Synthetic Resins and Stoving Enamels. D. H. Finn, S. R. Finn and R. M. A. Welchman. To: Ministry of Supply.

Production of phenol formaldehyde liquid resins by slow and controlled condensation under refluxing conditions, using equimolecular proportions of phenol and formaldehyde, using ammonia, triethanolamine, pyridine or trimethylamine as catalyst. Freedom from pinholes is claimed for coatings made from such resins.

B.P. 600,669. Application date: 30.4.45. Accepted: 15.4.48.

Improvements in and relating to the Heating of Moulding Materials by High-frequency Electric Fields. E. M. Leyton and H. M. Nelson. To: General Electric Co., Ltd.

Refers to the preheating of a plurality of pellets by bringing them into surface contact with one electrode of an H.F. system whilst the second electrode (or electrodes) are movable independently.

B.P. 600,718. Application date: 14.9.44. Convention date (U.S.A.): 25.10.41. Accepted: 16.4.48.

Improvements in or relating to Thermosetting Resins. To: Westinghouse Electric International Co.

Improved thermosetting resin of low electrical loss produced by polymerizing monostyrene and a half ester reaction product of maleic acid and castor oil incorporating as plasticizers coumarone-indene resins, halogenated aryl-compounds of substantially zerodipole moment or hydrogenated naphthalene.

B.P. 600,723. Application date: 26.9.44. Convention date (Switzerland): 1.10.43. Accepted: 16.4.48.

Manufacture of Artificial Filaments, Ribbons, Foils, Capsules and the like. To: Society of Chemical Industry, Basle.

B.P. 600,763. Application date: 18.4.45. Accepted: 19.4.48.

Improvements in or relating to the Production of Compositions containing Synthetic Resins for Use as Cements, Coatings or the like. W. Blackman and J. E. S. Whitney. To: Ministry of Supply.

Composition suitable as base for coatings or adhesives, prepared by heating together rubber, a drying oil containing a conjugated double bond (tung oil) and an acid-catalysed phenol-aldehyde resin, care being taken that such heating is not carried too far to prevent preoxidation or prepolymerization of the tung oil.

B.P. 600,765. Application date: 20.4.45. Accepted: 19.4.48.

Improvements in or relating to Processes of Preparing Interpolymers of Vinyl Aromatic Compounds and the Products Resulting therefrom. To: Monsanto Chemical Co.

Refers to the interpolymerization of a vinyl aromatic hydrocarbon (styrene) and fumarodinitrile.

B.P. 600,800. Application date: 18.6.47. Accepted: 19.4.48.

Improvements in or relating to the Production of Compositions containing Synthetic Resins for Use as Cements, Coatings or the like. W. Blackman and J. E. S. Whitley. To: Ministry of Supply.

Similar to B.P. 600,763, but using oiticica oil or low-viscosity dehydrated castor oil. The phenolic resin is prepared from p-tertiary amyl phenol or p-tertiary butyl phenol.

B.P. 600,904. Application date : 20.5.43. Accepted : 22.4.48.

Improvements in the Production of Vinyl Halide Resins. J. J. P. Standinger and B. K. Kelly. To : The Distillers Co., Ltd.

Polymerization of vinyl halides and/or vinylidene halides in aqueous emulsion or dispersion in the presence of a saturated lower aliphatic alcohol (methanol) and crotonic acid, a peroxide catalyst, and an unsaturated chlorinated hydrocarbon (trichloroethylene, etc.). The products so obtained are easier to plasticize.

B.P. 600,905. Application date : 20.5.43. Accepted : 22.4.48.

Improvements in or relating to Polymerization Reactions. J. J. P. Standinger and M. D. Cooke. To : The Distillers Co. Ltd.

Polymerization of vinyl halides and/or vinylidene halides in the presence of crotonic acid.

B.P. 600,916. Application date : 3.8.44. Convention date (U.S.A.) : 17.8.43. Accepted : 22.4.48.

Alkyl Ester Copolymers. E. L. Kropa. To : American Cyanamid Co.

Refers to copolymers of diallyl phthalate and diethyl fumarate.

B.P. 600,917. Application date : 5.9.44. Accepted : 22.4.48.

Emulsion Polymerization. E. L. Kropa. To : American Cyanamid Co.

Polymerization of a mixture consisting of an unsaturated alkyd resin and styrene.

B.P. 600,924. Application date : 22.12.44. Convention date (U.S.A.) : 24.12.43. Accepted : 22.4.48.

Improvements relating to Resin Emulsions. To : Johnson and Johnson (Gt. Britain), Ltd.

Textile printing inks comprising a pigment containing emulsion having an aqueous continuous phase and a disperse phase of a normally solid polyvinyl acetate or polyvinyl butyral together with water insoluble plasticizer and a thickener for such emulsion.

B.P. 600,948. Application date : 30.7.45. Convention date (U.S.A.) : 11.10.44. Accepted : 22.4.48.

Resin-bonded, Moulded or Shaped Articles and Their Preparation. M. E. Hughes. To: Shell Development Co.

B.P. 600,950. Application date: 20.5.43. Divided out of No. 600,904. Accepted: 22.4.48.

Improvements in the Production of Vinyl Halide Resins. J. J. P. Standinger and B. K. Kelly. To: Distillers Co., Ltd.

B.P. 600,961. Application date: 19.9.45. Convention date (U.S.A.): 20.9.44. Accepted: 23.4.48.

Improvements in or relating to the Impregnation of Wood with Urea Formaldehyde. To: E. I. Du Pont De Nemours and Co.

B.P. 600,999. Application date: 7.12.45. Accepted: 23.4.48.

Printed Sheet Materials. W. E. F. Gates. To: Imperial Chemical Industries, Ltd.

Printing of polythene sheets. The printing operation is carried out whilst the polythene is molten, with a printing mixture which is capable of forming a solid solution with polythene. Cooling is carried out rapidly after printing.

B.P. 601,050. Application date: 21.4.44. Divided out of No. 586,708. Accepted: 26.4.48.

Process for the Lamination of Plastic Sheet Material. To: E. I. Du Pont De Nemours and Co.

Lamination of plastic sheets which do not usually adhere readily to each other, but one of which will adhere to glass by applying to one side of the sheet a water-insoluble plasticizer for the plastic sheet, and subsequently a liquid polysilicic acid sol and a volatile solvent for both plasticizer and the acid sol, placing a sheet of different plastic which readily adheres to glass in contact with the coated side of the first sheet, and uniting the whole structure by heat and pressure.

B.P. 601,075. Application date: 25.9.45. Convention date (U.S.A.): 14.9.44. Accepted: 27.4.48.

Improvements in or relating to the Preparation of Mono-substituted Iso-melamines. To: American Cyanamid Co.

B.P. 601,076. Application date: 26.9.45. Convention date (U.S.A.): 27.9.44. Accepted: 27.4.48.

Manufacture of Vinyl Cyanide. To: Imperial Chemical Industries, Ltd.

Refers to the catalytic synthesis of vinyl cyanide from hydrogen cyanide and acetylene, using liquid phase catalysts consisting of solutions of cuprous salts.

B.P. 601,101. Application date: 5.6.42. Accepted: 28.4.48.

Improvements in or relating to Synthetic Resins. T. Urbanski. To: Ministry of Supply.

B.P. 601,123. Application date: 16.3.45. Accepted: 28.4.48.

Improvements in the Production of Synthetic Linear Condensation Polymers. To: British Celanese, Ltd.

Self condensation of beta-amino propionic acids.

B.P. 601,191. Application date: 30.10.45. Accepted: 29.4.48.

Improvements in the Polymerization of Vinyl Acetate in Emulsion. D. Cleverdon and J. J. P. Standinger. To: The Distillers Co. Ltd.

B.P. 601,223. Application date: 9.10.44. Convention date (U.S.A.): 8.9.43. Accepted: 30.4.48.

Improvements in or relating to Polymerization of Butadiene —1, 3-Hydrocarbons and the Polymerization of Mixtures of Copolymerizable Unsaturated Organic Compounds, at least one of which is a Butadiene —1, 3-Hydrocarbon in Aqueous Emulsion. C. F. Fryling. To: B. F. Goodrich Co.

B.P. 601,256. Application date: 5.6.45. Accepted: 3.5.48.

Improvements in or relating to the Welding together of Films or Sheets of Thermoplastic Material. C. Haim and H. P. Zade.

High-frequency welding of polythene by interposing between the polythene films and the electrodes a p.v.c. film applied by spraying, brushing, etc. The welding operation can be continuous where roller electrodes are employed.

B.P. 601,258. Application date: 18.6.45. Accepted: 3.5.48.

Improved Polymerization Products, particularly for use as Lubricating Oil Additives. To: Standard Oil Development Co.

B.P. 601,305. Application date: 28.12.43. Accepted: 4.5.48.

Improvements in or relating to Monofilament Synthetic Yarns, Strands or Strips and Fabrics woven therefrom. To: The Firestone Fire and Rubber Co.

Monofilament polyvinylidene chloride upholstery yarn, strand or strip having one convex and one concave surface.

MICROSCOPIC EXAMINATION OF PLASTIC PRODUCTS

(Continued from page 501)

as might be desired. However, there was sufficient evidence on which to come to the conclusion that the histological structure of the shell particle was very little altered. Evidence of a confirmatory nature, however, is produced when the section is examined at higher magnifications, as seen in Fig. 328.

It will be remembered that, when dealing with the histological characteristics of the coconut shell, it was suggested that one of the reasons for the filler producing higher strengths than was expected was probably the existence of pit channels in the cell walls, which, in the natural structure, coincided with those in adjacent cells and thus formed an intercommunicating network of channels throughout. If this were so, it was further suggested that when the ground shell was incorporated as a filler in a moulding powder, it was possible that the pit channels and internal cavities of the cells might become filled with resin, thus producing a condition wherein the filler particles were each thoroughly impregnated with the resin and were embedded in a continuous matrix of this material.

(To be continued.)

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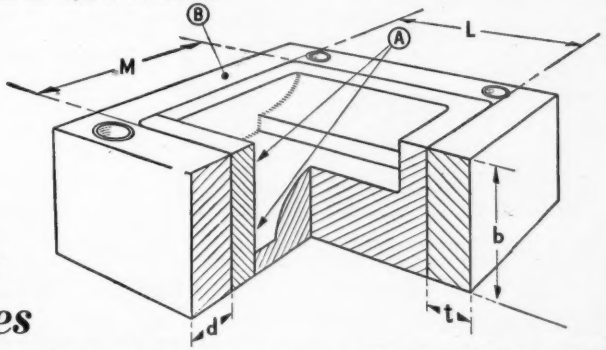
Leaves from a Moulder's Notebook

This is the twenty-first in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. Nos. 1-12 in this series are now available in booklet form and B.I.P. will be pleased to send a copy of this and subsequent notes on request. Comments and enquiries are welcome.



Mould Forces

In designing a large mould of the built-up type, more than usual care must be taken to ensure that the strength of the walls is sufficient to support the internal moulding pressure without distortion. Deflection of the walls may open the joints in a mould and allow moulding material to percolate in the spaces or gaps thus provided. The method of determining stresses and deflection by known beam formulæ is simple and straightforward, but the weakening of a mould by dowels is a possibility which should not be overlooked.

For instance, the mould illustrated, in which the punch is in sheer with the die at 'A', was constructed for deflection at point 'A' within the limits allowed — namely .010 in. The designer calculated that the deflection of the wall 'A' would be .005 in. and the elongation of the walls 'B' would be .004 in. In practice, under moulding pressure conditions, the actual opening of the wall at 'A' was approximately .085 in.

This discrepancy was due to two departures from the conditions about which the calculation had been based: (1) the mould pressure had been increased by 50 per cent.; and (2) the dowels had been included in the corner positions shown and no allowance in strength had been made for their effect.

Recalculation on a beam section reduced sufficiently to allow for the dowels, gave the deflection as .080 in.

The possible weakening effect of dowels is an element in mould design so easily overlooked that this incident is recorded as a warning against similar pitfalls in calculating deflections.

The formulæ used were:

$$\text{For Deflection} = \frac{5}{384} \times \frac{WL^3}{EI}$$

$$\text{For Elongation} = \frac{WM}{2Ebt}$$

Where W = Internal force

E = Young's Modulus = 30×10^6

I = the moment of inertia = $\frac{bd^3}{12}$

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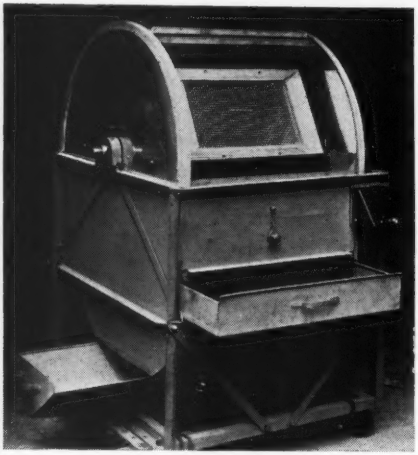

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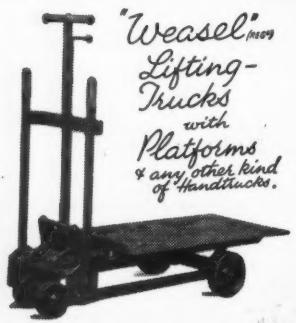

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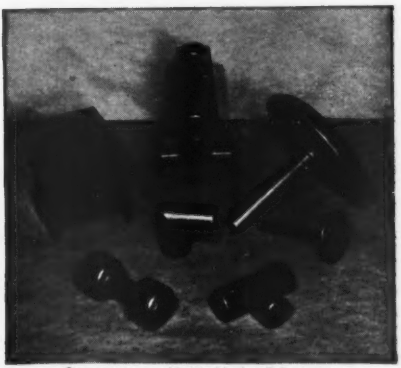

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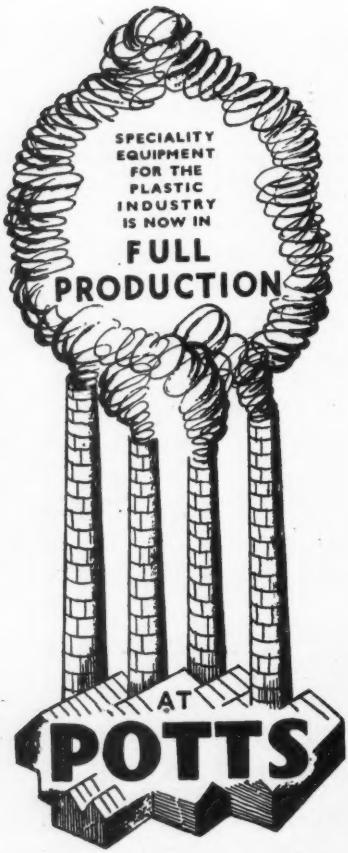

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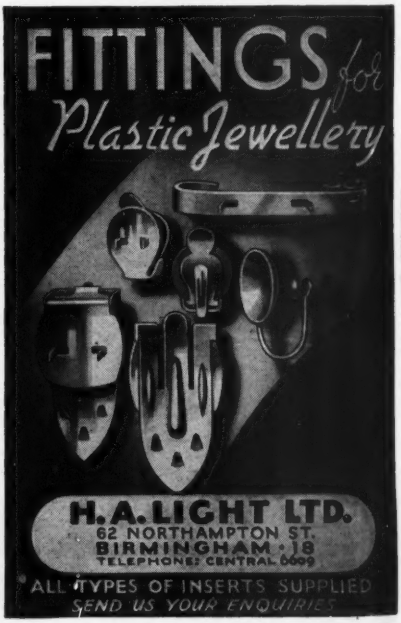

THE TENSILE STRENGTH OF MONSANTO Lustron

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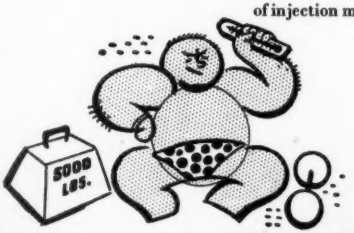
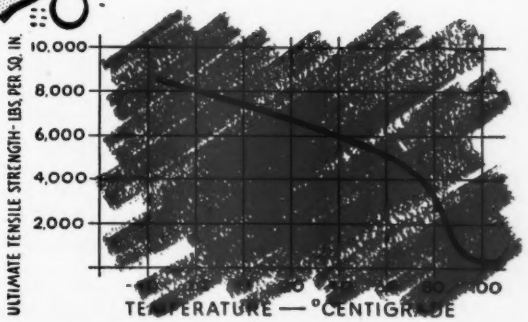
The tensile strength of Lustron was determined over a range of temperatures using injection moulded dumb-bell shaped test specimens of $\frac{1}{2}'' \times \frac{1}{4}''$. In the graph below, tensile strength is plotted versus temperature. The curve shows that the toughness of injection moulded Lustron increases as temperature decreases.





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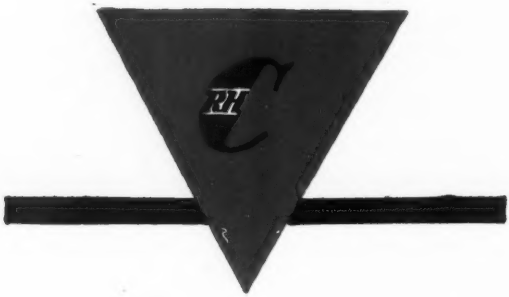

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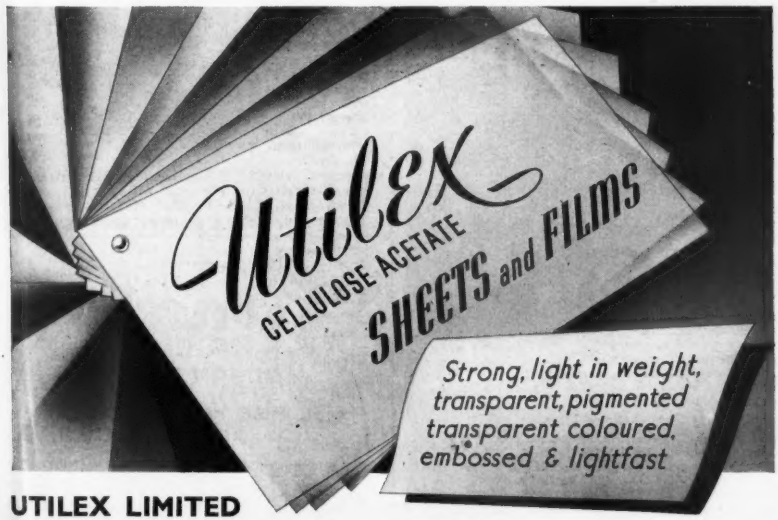
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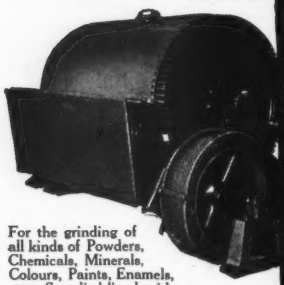

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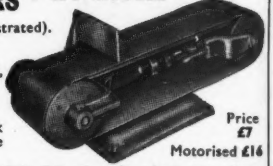

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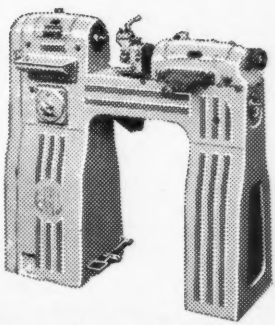

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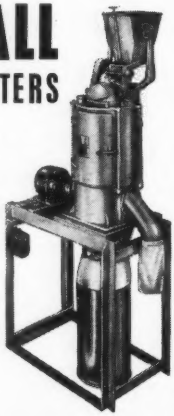

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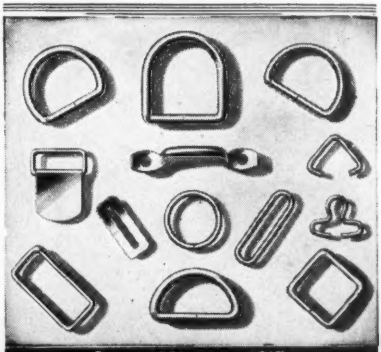

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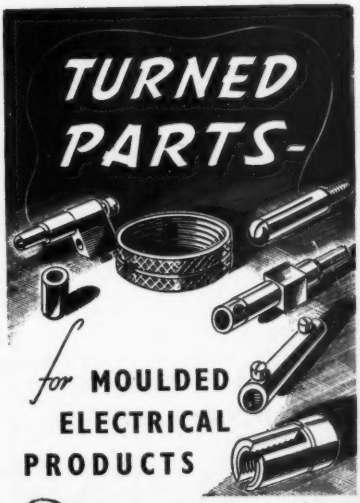

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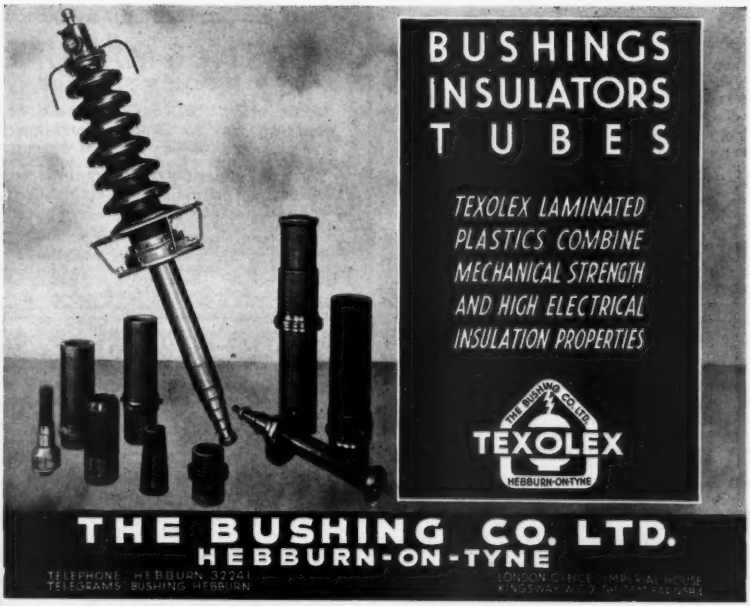
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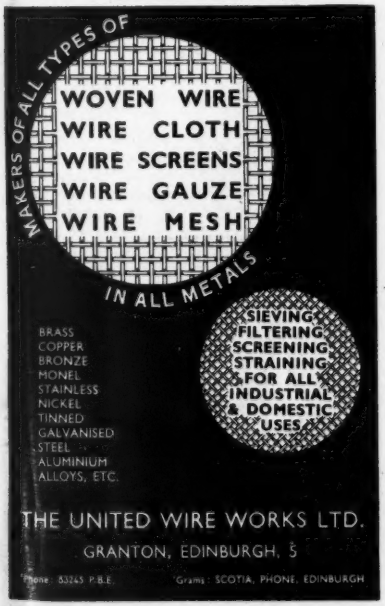
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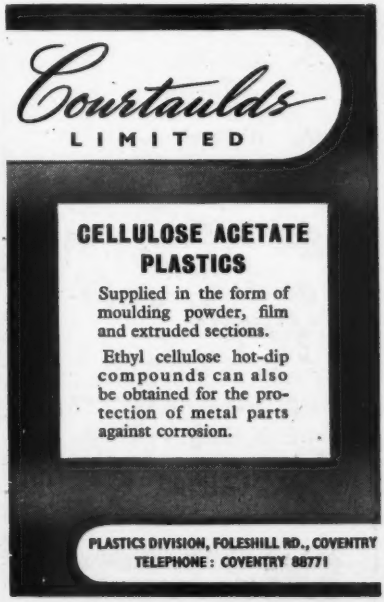
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One E.M.B. 4-oz. capacity machine, complete with compressor motor, etc., price £1,600. Box 5868, care of "Plastics." 137-444

Heavy Punching Machine, specially suitable for envelopes, labels, etc., cutting area 24-in. by 28-in., arranged for continuous or single cutting, in perfect working order. Inquiries to Box 5840, care of "Plastics." 136-17

Shipton Moulding Press for immediate disposal, little used in excellent condition. Box 5843, care of "Plastics." 136-20

Engravers (electric) for all plastics, just plug into light, simple or fancy designs are easily cut into plastic objects, 52s. 6d. Bulls (Pla), 246 High Street, Harlesden, N.W.10. 136-x6497

P.V.C. Artificial Leather Making Machine with pilot plant, equipment and accessories complete in original new condition, immediate delivery, inspection invited. For specification, particulars and price, apply: Box 5864, care of "Plastics." 136-5

One second-hand Henley 1-in. lead extrusion machine, comprising:
(1) Type 1-in. extrusion machine.
(2) Control pillar.
(3) Ward Leonard generating set, complete with contactor panel and starter.
(4) Capacitors for the above generator.
(5) Oil pump and cooler complete with motor.
(6) Air compressor and receiver complete with motor.
(7) Automatic tubular furnace complete with pig magazine.
All the above are fitted with electrical equipment suitable for 200 volt, 2 phase, 50 cycle A.C. supply. The feed and take-up stands are not included. Box 5865, care of "Plastics." 136-4

Portland Cement Briquette Testing Machine, in perfect order, £12 10s. Pattison, 200 Siddals, Derby. 136-x5675

Two-three Daylight Block Presses, complete with electraulic pump, oil storage tank, filter and 13 base plates; block size 60-in. by 30-in., ram diameter 18-in., hydraulic pressure 150-3200 lb. per sq. in., platens tested at 60 lb. per sq. in.
296 nickel-plated brass polishing plates, size 28-in. by 55-in., thickness .060-in.
483 nickel-plated brass polishing plates, size 27-in. by 54-in., thickness .060-in
Application to inspect: Manager, Messrs. Courtaulds, Ltd., Little Heath Works, Plastics Division, Coventry. 136-32

Presses. One Burroughs 5-in. dia. ram, upstroke; one Burroughs 4-in. dia. ram, downstroke; one Burroughs 6-in. dia. ram, downstroke; four Burroughs 8-in. dia. rams, downstroke; two Burroughs 9-in. dia. rams, downstroke; one special 3-in. dia. ram, upstroke; one special 4-in. dia. ram, upstroke; two 450-ton block presses complete with pump, tanks, pipework, etc., table 6 ft. by 3 ft. 8 ins., gap 6 ft., stroke 36 ins., all suitable for 3,000 p.s.i. Further details from, Engineering Services, Ltd., 265 Broad Street, Birmingham, 1. Phone, Midland 1411. 136-x5753

Machinery, Tools and Plant Wanted

Wanted for purchase, two 8-oz., one 12- or 24-oz. injection-moulding machines, Reed-Prentice preferred but will consider other makes. Reply with full particulars and price to Box 5873, care of "Plastics." 136-36

Edgewick 1½-oz. or S.H.3 machine wanted. Full details to Box 5874, care of "Plastics." 136-34

Pelleting Machine, max. capacity approx., 1½ dia. pellets, any condition. Box 5870, care of "Plastics." 136-2

PRODUCTION CAPACITY AVAILABLE AND WANTED

Repetition in Ebonite, Erinoid, etc. Capstan lathe work. Mansell, Temple Street, Rugby. 137-3687

Kingston Plastics, Ltd., Unity Works, Union Street, Kingston-on-Thames, have all the facilities for cleansing, sorting, grinding, kibbling and reprocessing of thermo-plastic materials. Phone, Kingston 8405. 138-4012

Increase sales appeal by colour!
Hand colouring on any plastic smallwares expertly carried out with taste. Long runs only accepted. Send your samples for quotations to Proda (London), Ltd., 17 Bishop's Bridge Road, London, W.2. 139-4972

Good deliveries. Presswork up to 40 tons, tools, fixtures, jigs. All sorts light engineering, commercial plating, galvanizing; also woodwork, assembling, etc.; mass production. Universal Components, Ltd., 19 Sunderland Terrace, Bayswater, W.2. Bayswater 6776 137-6444

P.V.C. silk screen printing. Table cloths, curtains, nursery patterns, etc. Capacity available for quantity runs. Quality work. Daily deliveries. Guaranteed adhesion and fastness of colour. Davis (Patents), Ltd., 18 Phipp Street, London, E.C.3. 137-6445

Dohm, Ltd., pulverize raw materials everywhere. 167 Victoria Street, London, S.W.1. zzz-224

Calendering. Capacity available as a result of additional plant installation. High-grade work from long experience. Own or customers' materials. Laboratory service if required. Write Box 4508, care of "Plastics." 136-310

Work wanted. Spur gear cutting, planing, shaping, centre late work, machine construction. S. J. Clarke and Sons (Engineers), Ltd., 54A St. Paul's Street, London, N.1. Phone, Canonbury 2260. 137-322

Injection moulding specialists have moulding capacity up to 4 oz. Consultants on all injection moulding problems. Please send inquiries to Box 5328, care of "Plastics." zzz-236

Injection moulding capacity available on 3-oz. injection moulding machine for short and long runs. Box 5327, care of "Plastics." zzz-235

Small turned parts, including inserts, etc., of all types for the plastic trade supplied cheaply, accurately and rapidly. Only modern Swiss-type automatics used, ensuring first-class quality and finish. Quotations by return. Bristol Repetition, Ltd., Sales 2B, Portishead, Bristol. 138-366

Compression moulding capacity available. Short or long runs, 75-ton presses. J. H. Berry (Plastics), Annesley Woodhouse, Notts. Phone, East Kirkby 2151. 140-368

Bellsham and Hirst fabricate from plastic and acrylic sheet anything from umbrella handles to lampstands. We can produce your components. 643 Leeds Road, Outlane, Huddersfield. 136-x5752

Perspex. Will fabricators submit samples and quotations of any snappy made-up articles in clear Perspex to firm having several tons of ⅛-in by 5/32-in material available which they wish to have made up into saleable lines for home and export markets. S. G. Young, 154-6 Blackfriars Road, London, S.E.1. 137-x5024

Multi-daylight press capacity wanted for pressing sheets at least 1-ft. square. Larger platen area could also be utilized. Large contract available and manufacturers must be prepared to modify their presses for water cooling. Box 5845, care of "Plastics." 137-435

Plating on plastics. Silver, chrome, nickel, copper by the non-conductive specialists. Atom Plating and Polishing Co., Ltd., 176 Albion Road, Stoke Newington, N.16. Phone, Clissold 4775. 138-437

P.V.C. flanged tubes for more efficient and more economical production of inflatable toys, etc. Full details and prices on application to Modo, Ltd., 1007 Argyle Street, Glasgow. 137-439

—RAW MATERIAL AVAILABLE AND WANTED—

Perspex required. Cream 120 green 621 ¾-in. Reply stating lowest possible price for quantities. Box 5826, care of "Plastics." 136-x6414

Perspex, clear, in sheets 4 ft. by 3 ft. 5/32-in. thick, large quantity available, low price, immediate delivery. Your inquiries, and keen quotation and samples, to A. Drury, Heathfield, Sussex. 136-33

100,000 sheets celluloid, 1-ft. and 1-ft. 4-in. Carbot, Ltd., 201-205 Long Lane, London, S.E.1. Phone, Hop 1762. 137-x5077

Raw Material Available and Wanted (contd.)

S. R. F. FREED, LTD.,
THE STOCKISTS OF SHEETS, RODS, TUBES, OFF-CUTS AND SCRAP,
OFFER OTHER LINES WHICH CAN BE USED IN COMBINATION WITH PLASTICS UTILIZING ANIMAL AND VEGETABLE PRODUCTS.
Such as tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes vegetable ivory nuts, porcupine quills, goose and duck feathers, and barrels, etc.
S. R. F. FREED, LTD.,
27b HIGH STREET, SOUTH NORWOOD, S.E.25.
Phone, Livingstone 4042.

zzz-462

Urgently required, clear cellulose acetate, thickness 30 thou., either Celanese or B.X. material. Send quotation with sample to Box 5858, care of "Plastics." 136-10

Flat Perspex sheets, clear, coloured, 54 ins. by 48 ins., or sizes cut to shape; corrugated Perspex roof lights; aluminium, alloy and plastic sheeting and mouldings. Henry Moat and Son, Ltd., Atom Works, Newcastle. 136-11

MOON AIRCRAFT, LTD.,
SPECIALISTS IN MANIPULATED AND FABRICATED WORK.
OFFICIAL I.C.I. STOCKISTS FOR PERSPEX.
Have available from stock all thickness in clear and colour flat sheet cut to customer's sizes.
Inquiries, prices and particulars upon application to
CLIFT WORKS, BOX, WILTS.
Phone, Box 188.
London Office:
GROSVENOR GARDENS HOUSE, S.W.1.
Phone, Victoria 9182-3. 138-256

Quantity colours for disposal as odd parcels, in pink, brown, yellow, black and blue. Prices reduced 100% to clear. Box 5839, care of "Plastics." 136-16

Plastic scrap.
We buy.
We segregate.
We sell. Box 5847, care of "Plastics." 136-22

Approximately 2 tons of Scarab moulding material, made up as follows: 11 cwt. red, 11 cwt. orange, 12 cwt. blue, 6 cwt. jazz. Offers invited. Box 5849, care of "Plastics." 136-23

For sale, ½-1 ton clear, clean polystyrene scrap; best offers wanted. Also available, clear, transparent acetate sheets, 1½-2-2¼-3 mm. thickness. Reply to Box 5850, care of "Plastics." 136-24

Always large stocks of
CASEIN
rods, tubes and sheets,
PERSPEX
sheets up to 1-in. thick.
CELLULOSE ACETATE.
S. Rosenfeld.
93 Aldersgate Street, E.C.1.
Phone, Monarch 4686. 138-0250

Polythene. Approximately 4½ tons of virgin green alkathene (very pale green, almost white), grade 20, for immediate delivery, 3s. per lb. Williams, 203 Albany Street, N.W.1. Euston 4804. 136-30

Perspex. R. Denny and Co. Stocks available for immediate delivery. Sheet or cut to specification. Inquiries invited for display stands, panels, windows, windscreens, etc.; quotations by return. 271 High Street, Acton, London, W.3. Phone, Acorn 5777. 141-429

Raw Material Available and Wanted (contd.)

TRANSPARENT WRAPPING FILM WANTED.
SHEETS 10 INS. BY 8 INS. UPWARDS,
OR REELS 4 INS. UPWARDS.
ANY QUANTITY FOR CASH.
SEND SAMPLE AND DETAILS.
ALLANS,
37 FARRINGDON STREET, E.C.4.
Central 5947. 141-432

Polystyrene wanted (virgin), light blue, light pink; good price paid. Write Box 5846, care of "Plastics." 137-434

Polythene Powder (white) for disposal, any mesh, well below maker's price, sample sent upon request. Box 5835, care of "Plastics." 138-436

P.V.C. compounds, recompounded material free from all impurities, large quantities available in granular and strip form ready for use, wide variety of colours, available from 6d. a lb. Apply Box 5859, care of "Plastics." 137-442

2,000 SHEETS CRYSTAL-CLEAR 40-THOU. ACETATE.
Size 56 ins. by 25 ins
Weight per sheet 2 lb. 14 ozs.
LOW PRICE FOR COMPLETE CLEARANCE.
ALSO 1 TON 3-MM.
Size 54 ins. by 27 ins. Weight per sheet 7½ lb.
ALLANS,
37 FARRINGDON STREET, LONDON, E.C.4.
Cen 5947. 141-431

Cork! Cork! British Cork Mills, Ltd., 167 Victoria St., London, S.W.1. Vic 1414-6. zzz-238

Perspex offcuts for sale, large sizes up to 33 ins. by 24 ins., slightly shaped, large quantity for disposal, mostly ⅛ in. For appointment to view write to Box 5875, care of "Plastics." 136-x6539

For sale, ⅛-in. and ¼-in. coloured Perspex and various thicknesses clear Perspex; also sheet acetate, 30-thou. clear, 40-thou., 80-thou., and 3-mm. black, and 80-thou. brown. All new material, available for immediate delivery. Write Box 5876, care of "Plastics." 136-x6538

IF YOU ARE LOOKING FOR IDEAL MATERIAL FOR MAKING
Ladies' and children's handbags, shopping bags, knitting bags, beach bags, brief cases, purses, etc.,
WHY NOT TRY "BRITIONA" PLASTIC (P.V.C.) EMBOSSED SHEETING?
25 to 90 thou. in eleven attractive colours.
BRITIONA CHEMICALS LTD.,
MULKERN ROAD WORKS, LONDON, N.19.
Phone, Archway 4014-5. zzz-231

An entirely new embossed sheeting, ideal for upholstery and fancy leather goods, unbacked, extremely strong, tough and pliable, excellent graining, antique, morocco, calf, pigskin, etc., all standard colours, 48-in. width. Almex, Ltd., Exchange Buildings, Stephenson Place, Birmingham, 2. Midland 0682.
Cuprex, Ltd., 120 Moorgate, London, E.C.2. Metro 9641. zzz-223

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. 139-4965

Buna-plast, a blending of synthetic rubber and P.V.C. specially processed for manufacturing leather substitute: this material is far superior to plasticized P.V.C., inquiries welcomed. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-230

P.V.C. calendering compound in a range of opaque colours. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-229

Polystyrene moulding scrap urgently required, state amount available and send small sample. Box 3185, care of "Plastics." zzz-228

Raw Material Available and Wanted (contd.)

1st quality virgin cellulose acetate moulding powder available. Box 3184, care of "Plastics." zzz-227

Polythene moulding powder (reconstituted) in black natural and a variety of colours. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-226

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-225

P.V.C. For sale, clean sheeting cuttings and cable strippings. John Castle and Co., Ltd., 18a Newport Street, Lambeth, S.E.11. 137-375

Perspex. For sale, about 5 tons clean, clear scrap and small offcuts. John Castle and Co., Ltd., 18a Newport Street, Lambeth, S.E.11. 137-374

Polystyrene scrap or surplus stocks of virgin material wanted. Box P.35, Nevin D. Hirst (Advertising), Ltd., 23 Mount Preston, Leeds, 2. 137-0311

Advertiser has approx. 3 cwt. of .010-in. Dufay Chromex and approx. 33 lb. of .001 Clarifoil for disposal. Offers invited. Box 5315, care of "Plastics." 136-x4624

D. H. Ridout and Son, Ltd. Reg. Office, 12 Stedman Road, Southbourne, Bournemouth. Phone 505. Official stockists for I.C.I. acrylic Perspex, clear and coloured, and Crinothene sheeting in all shades.
New Perspex sheets, 48 ins. by 36 ins., by 1-16 in. to 3-16 in., from 45s. per sheet. Other sizes pro rata.
Scrap crystal and amber Perspex from 1s. 3d. to 2s. per lb., according to gauge and quantity required.
Acetate and celluloid transparent sheeting from 1s. 6d. per lb.
Coloured transparent and opaque celluloid and acetate sheeting from .007 in. to .120 in., from 3s. 9d. per lb.
Crystal acetate, 2, 3, 4, 5 and 6 mm., from 5s. 6d. per lb. Full-size sheets.
Large stock of various plastic materials suitable for lamp shade, toy makers and upholsterers, etc.
Samples and stock list on request. 136-41

Manufacturers urgently require for cash large or small quantities of clear Perspex offcuts, flat or curved aircraft panels, etc., thickness, 1-16 in., ⅛ in., 5-32 in., 3-16 in. Advertiser, 28a New Buildings, Price Street, Birmingham, 4. 136-40

P.V.C. sheet cuttings. Quick delivery, sorted as requested. Box 5342, care of "Plastics." 136-372

Catalin off-cuts required, particularly cylinders and sheet. Send details. Box 5312, care of "Plastics." 136-371

Perspex acrylic sheet.
Large range of colours from 1-16 in. to ½ in. Large stocks, good delivery.
J. H. Berry (Plastics), Annesley Woodhouse, Notts. Phone, East Kirkby 2151. 140-569

Methyl methacrylate scrap is wanted for import to Norway. We are also interested in renting injection and pressing moulds on good terms. Nordisk Formstoff, Tollbugt, 30, Oslo, Norway. 136-367

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Young mechanical engineer to be trained as assistant to the technical manager required by North-west plywood factory. State qualifications, previous experience and salary expected. Box 4752, care of "Plastics." 136-307

Rubber chemist required by large general rubber goods manufacturers in Manchester area, experience in development and analytical work is required, and some knowledge of plastics would be an advantage. Write, giving details of age, experience and qualifications to Box 5307, care of "Plastics." 136-370

Assistant chemist for research laboratory required, training to Higher National Certificate standard or equivalent, some experience with resins or plastics an advantage, but not essential. Apply in writing, giving full details of qualifications and experience, to Personnel Department, British Belting and Asbestos, Ltd., Scandinavia Mills, Cleckheaton. 136-31

Old-established firm manufacturing plastic goods have vacancy for assistant aged 25-30 to works manager, experience with cellulose nitrate and acetate advantageous, good salary and excellent prospects. Box 5780, care of "Plastics." 136-x6269

Situations Vacant (contd.)

Foreman required with technical and practical knowledge of extrusion. Apply, with full details of previous experience, Box 5871, care of "Plastics." 136-1

Assistant export manager required by well-known manufacturers of thermoplastic resin products; capable of working on own initiative, familiar with overseas markets, prepared to travel abroad for short periods, excellent prospects for right man. Apply for full particulars to Box 5866, care of "Plastics." 136-3

Experienced man wanted to take charge of bakelite moulding and deflashing plant. Write, giving full particulars of experience and salary required, to Box 5863, care of "Plastics." 136-6

Engineer for rubber and plastics works in West of England, age up to 45, all-round qualifications to cover control of maintenance (steam, electric—1,000 h.p. and hydraulic) and tool-room, and with flair for design and development of special-purpose equipment; the position offers wide scope for a live, practical man, commencing salary commensurate with experience and qualifications. Box 5861, care of "Plastics." 136-8

Sales representative required to call upon radio, automobile and allied trades with a view to obtaining orders for compression and injection plastic industrial products. Area vacant London and Greater London. Only representatives with contacts and experience in similar situation should apply. Box 5834, care of "Plastics." 136-12

Chargehand required with knowledge of injection and compression moulding. Write, stating experience and salary required. Box 5837, care of "Plastics." 136-14

Toolsetter required with knowledge of E.M.B., Reed Prentice and Daniel's presses. Write, stating experience and salary required. Box 5836, care of "Plastics." 136-13

Draughtsman and designer required, with experience of Bakelite moulds and dies, also capable of estimating cost of tools. State age, experience and salary required. Box 5842, care of "Plastics." 136-19

Energetic chemist to take charge of cellulose acetate moulding powder production in the North of England. Must be good colourist with ideas. House available. Salary £600 to £1,000, according to age and experience. Box 5844, care of "Plastics." 136-21

B.X. Plastics, Ltd., require a chemist for the Dundee Division of their plastics development department. A First or Second-class Honours Degree or equivalent is essential and some industrial experience would be an advantage. Salary according to qualifications and experience, but not less than £400 per annum. Full particulars to Personnel Manager, King's Cross Road, Dundee. 136-27

Draughtsman (senior), jig and tool, for interesting post with electrical and mechanical engineers, S.W. London area, must have served recognized apprenticeship and be conversant with press tools, plastic moulds, hydraulics and general tooling. Higher National education essential, some electrical knowledge preferred. Salary up to £450 per annum, according to age and experience. Write full particulars to Box 5848, care of "Plastics." 138-433

A number of chemists and physicists required for a new research station in Essex. Applicants should have a good degree in chemistry or physics with preferably a few years' experience in industrial research or development on electronics; housing accommodation will be provided for the right type of keen and ambitious workers, salary of £500-£700 per annum. Apply, stating age, qualifications and experience, to Box 5867, care of "Plastics." 137-443

A firm of chemical manufacturers in Leeds have a vacancy for an organic chemist with experience of synthetic resins. Salary according to age and qualifications; superannuation scheme in operation. Box 5869, care of "Plastics." 137-445

Wanted, agents to represent firm of Perspex sign manufacturers, etc., in the Midlands and South. Own car preferred. Commission basis. Apply with details to Milton Engineering Co., Ltd., Robert Street, Hyde, Cheshire. 136-37

Toolmaker required for plastic mould work, experience essential. First-class craftsmen only need apply. Send full details. "Seaforth," Watchett Works, Oakhurst Road, Southend-on-Sea 137-446

SITUATIONS WANTED

Man, 28, at present employed by large Toronto plant in Canada, where 13 years' practical experience and one year executive can be used to advantage; design, manufacture and use of all modern methods of moulding, including manipulation of sheet, approximately 11 years toolroom and two years design. If necessary will return to England by end of year. Box 5480, care of "Plastics." 137-x5351

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 137-3686

MISCELLANEOUS

Plastic cement for use with Perspex Acrylic sheets, Grade I, available in large or small quantities, clear and coloured. Trade inquiries from Evolite Plastics, Ltd., 325 Latimer Road, London, W.10. Phone, Lad 1879. 1138-04011

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street Leicester. 141-5699

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LONDON, N.5. 137-376

Photography by Behr will show your products at their best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 5298. 145-312

Waterproof inks for plastics in all colours for spray and hand brush. Free samples from Lakeland Ink Co., 98 Ocean Road, Barrow-in-Furness. 137-x4383

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 140-373

P.V.C. flanged tubes for more efficient and more economical production of inflatable toys, etc. Full details and prices on application to Modo, Ltd., 1007 Argyle Street, Glasgow. 137-440

Packing cases and boxes for all purposes. F. Rawle and Co., Ltd., 71 Kensington Avenue, London, E.12. Phone, Grangewood 2003. 147-441

Huts, Nissen type, reconditioned, 24-ft. span and 16-ft. span, any length. These huts are repaired, painted and completely reconditioned. Prompt despatch. Also other industrial buildings suitable for workshops, stores, garages, canteens, offices, etc. Write, phone or call for details: J. Thorn and Sons, Ltd., Box 138, Bramton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-239

50,000 map cases, from which can be cut two celluloid sheets 1 ft. 4 ins. by 1 ft. Carbot, Ltd., 201-205 Long Lane, London, S.E.1. Phone, Hop 1762. 138-x5335

To plastic manufacturers and others. New designs of low-cost patent automatic self-educating devices and toys, highly commended by National Press, "Just the thing for school children," novel containers for sample products, sweets, seaside rock, etc., automatic ready-reckoners. Sole manufacture and distribution offered progressive firm. Write, Patentee, Box 559, care of "Plastics." 136-x5692

Baldock Countess and Partners, 30 Saffron Platt, Guildford, Surrey. Consultants on all matters apertaining to industrial control and efficiency. 136-x6429

For disposal to best offer, Volumes 1 and 2, "1947 Modern Plastics Encyclopædia," condition as new, order duplicated. Box 5860, care of "Plastics." 136-9

Something new in plastics. Novel pocket magnifier, could carry advertising matter, designed for mass production. Patent application for sale, reasonable. Box 5838, care of "Plastics." 136-15

For sale, issues of "Plastics," January, 1942, to April, 1946, complete. O. Safir, 45 Woodside Avenue, Beaconsfield, Bucks. 136-26

Manufacturers, note! Wanted for export, seconds, discontinued, job lines. R. Turner, 12 Stone Grove, Park, Edgware, Middx. Phone, Edg 3298. 136-28

Extra sales appeal for your products, the Spraytex process, fabric spray finish for most surfaces, including metal, wood, paper, may double the sales of suitable products in both home and export markets. Write for brochure. Dept. H, Spraytex (Manchester), Ltd., 168 Oxford Road, Manchester, 13, or phone Ardwick 2474 or 1548. 141-430

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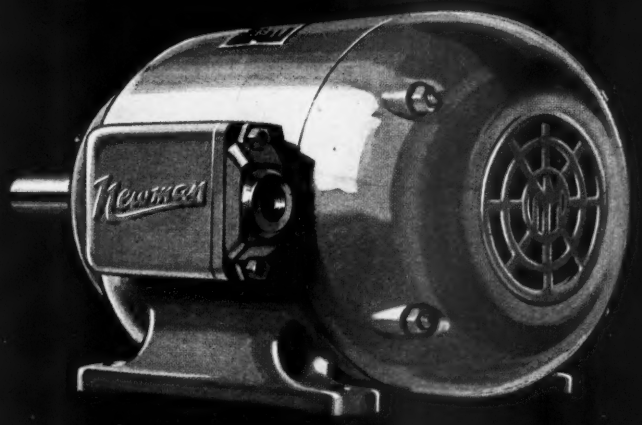

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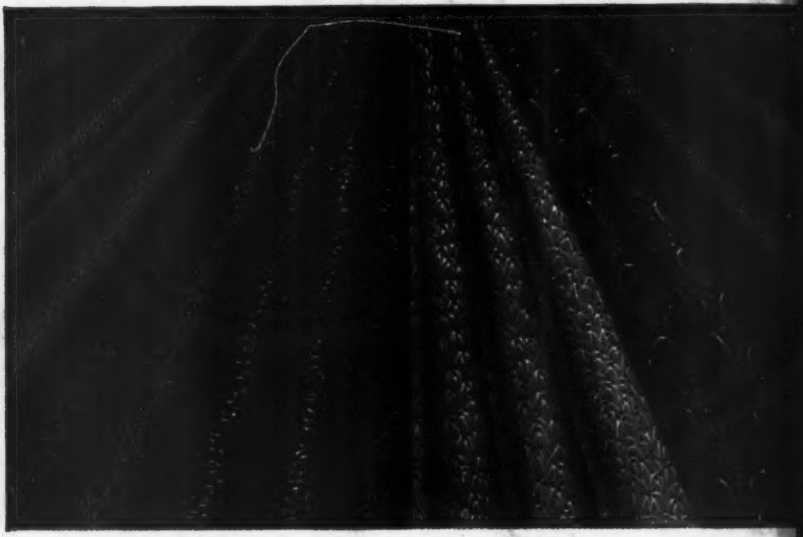

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